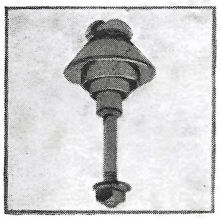
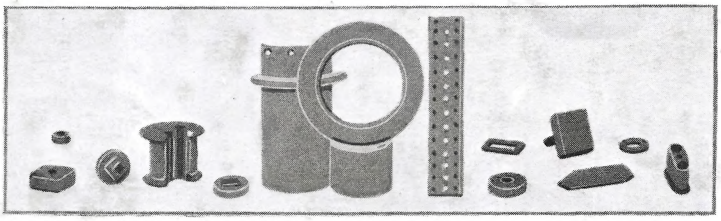
BOONTON BAKELITE

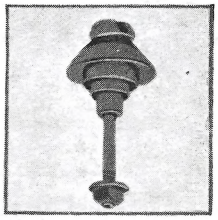
BOONTON RUBBER MANUFACTURING COMPANY

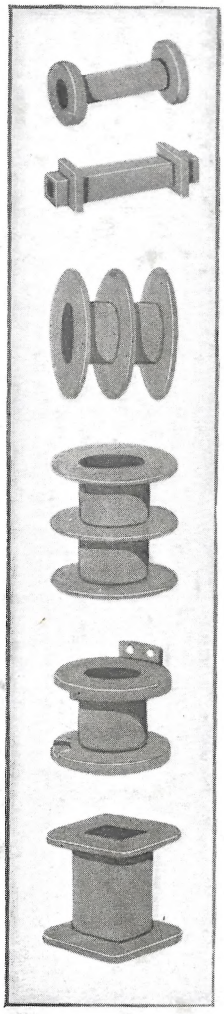
BOSTON BAKELITE

BB





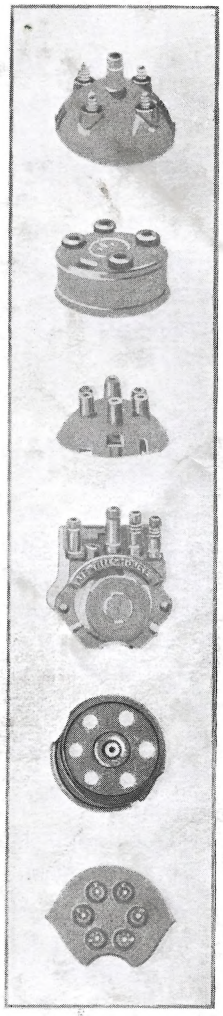


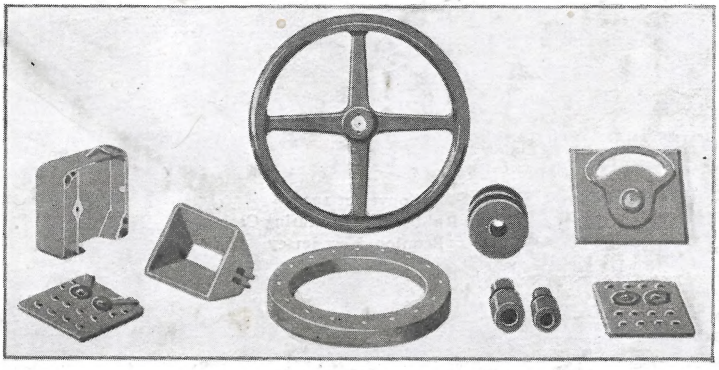


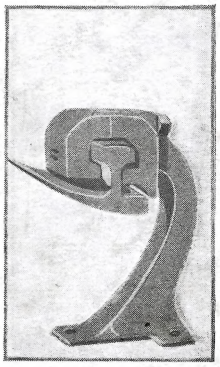
Boonton Bakelite

Molded Material for
Electrical Insulations
also for
Mechanical, Chemical
and Other Purposes

Boonton
Rubber Manufacturing Company
Boonton, N. J.







Introduction

THE engineer, in designing electrical machinery, has four groups of materials to consider: conducting, magnetic, structural and insulating. On the first three groups of materials, much fundamental and technical research has been done, but very little is known about insulation. The record of actual research has not been made public, and so far no one seems to have discovered just where the dividing line is between materials which conduct electricity and those which do not. In fact, science has still to find out just what insulation really is.

Few individuals are available and very few are qualified to undertake fundamental research in this highly specialized field, and equally few small enterprises are so organized as to be capable of carrying on fundamental research. It is hardly to be expected that many private individuals, even those with the necessary training, will attempt to work out problems connected with an industry about which so little information has been published and where the likelihood of immediate financial reward is so doubtful. It is perhaps for this reason that so little has been accomplished of real scientific benefit, compared with what has been accomplished in other directions.

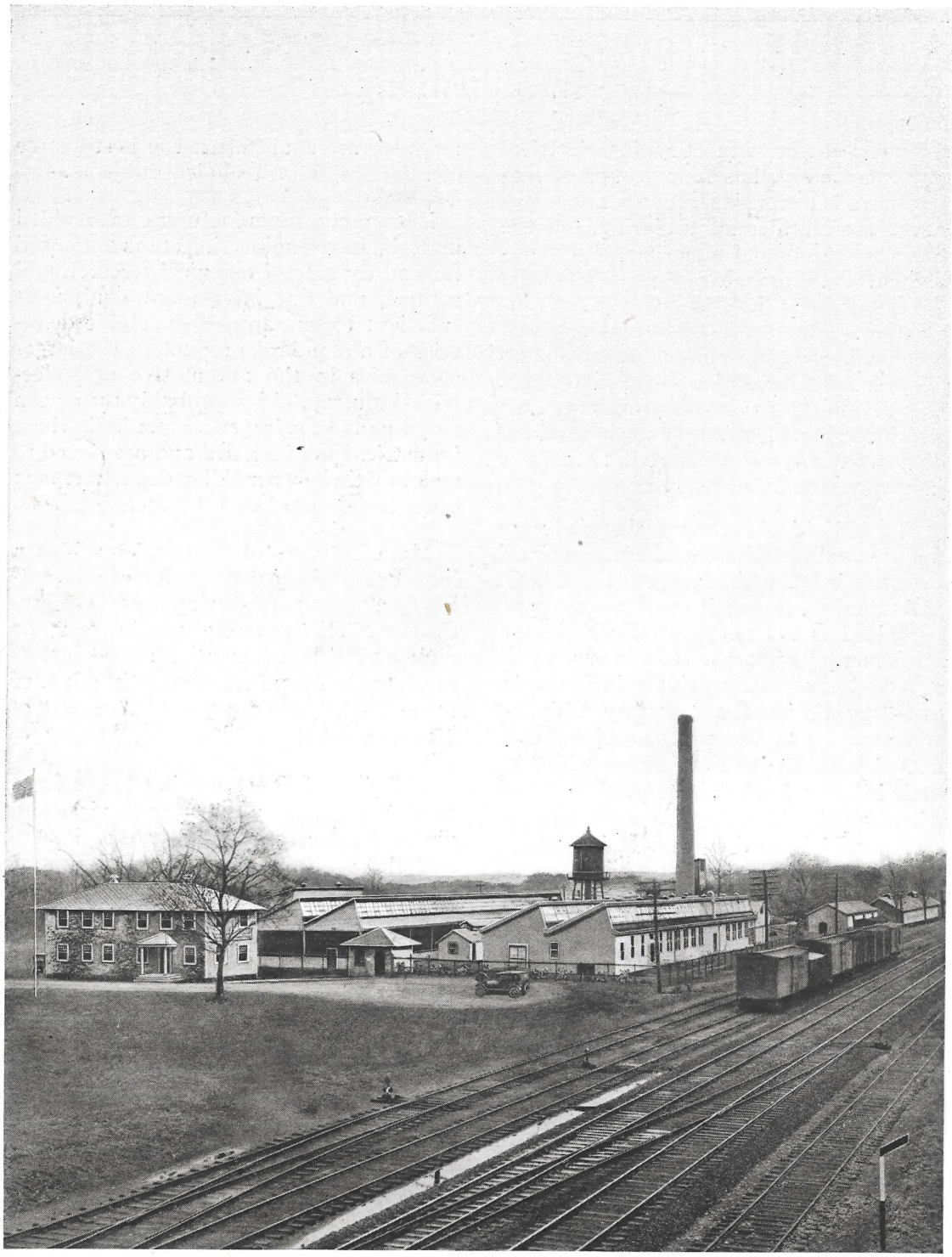
On the other hand, the art of making so called insulating materials has been greatly advanced by technical research, and although the record of much of this work reposes in the archives of the larger electrical companies, there are nevertheless smaller concerns specializing in branches like molding which have helped greatly to develope these materials for the electrical industry. The publications of such manufacturers are often the best source of information on technical subjects.

Not many manufacturers of molded material have engineering staffs organized for and capable of technical research and control, and few have plant equipment sufficient to guarantee dependable deliveries of a standard product to the larger companies in the automotive and electrical industry. This is probably the reason why some of the larger companies in these industries have installed and are forced to maintain their own molding departments in order to safeguard their business interests.

Manufacturers of electrical machinery have acknowledged the value of die-casting as a means of reducing the cost of production. The progress we have made molding Bakelite insulation means just as much to the manufacturers as the advance made in the past ten years in the art of die-casting metals.

The aim of the following pages is to carry a message of superior service, and we have endeavored to make the pictures and the printed page emphasize this as much as possible. The bulk of our business is made up of molded parts for electrical purposes, but the demand for duplicate parts for other uses is steadily growing.

If this booklet serves to stimulate the imagination of people of technical training and to interest them in this particular field for research, and if, further, it convinces the men in charge of manufacturing that they may safely depend upon sources of supply for molded material other than their own, we shall consider that it has been worth while.



PLANT OF THE BOONTON RUBBER MANUFACTURING CO., BOONTON, NEW JERSEY

The Beginning of Bakelite

BOONTON BAKELITE was the first condensation product of phenol and formaldehyde ever sucessfully molded in quantities for electrical purposes. We were pioneers.

The pieces shown in the illustration were made by us and first shown in connection with a paper read by Leo H. Baekeland, Sc.D., Ch.D., at a meeting of the American Chemical Society held in New York on February 5, 1909, and also at the *Fifteenth General Meeting of the Electrochemical Society held in Canada on May 8 of the same year.

Bakelite itself is a synthetic product. The initial product of condensation, when phenol and formaldehyde are properly treated in the presence of a catalytic agent, is a solid resinous substance: Oxybenzyl-methyl-englycol-anhydride.

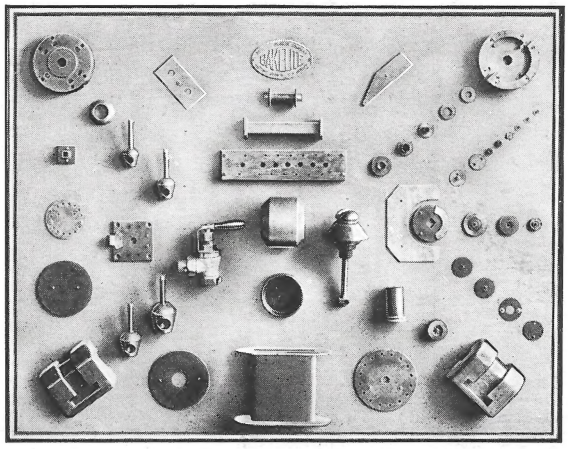
It is used for molded insulation as the binding material by mixing with it various filling materials like asbestos and woodflour to reduce the shrinkage in molding.

Asbestos was the first filling material used because of its fibrous character and its resistance to high temperatures, but it is always very difficult to produce pieces with this material which are entirely satisfactory from the electrical standpoint.

As licensees under the patents of the General Bakelite Company, we purchase the raw Bakelite and make our own molding mixtures, and for more than twelve years we have been continuously developing these mixtures for commercial use.

By keeping our process specifications in step with the advance in the art of making the raw Bakelite, we are able to produce molded insulation which has many advantages.

* See transactions of the American Electrochemical Society, Vol. XV, 1909, page 593.

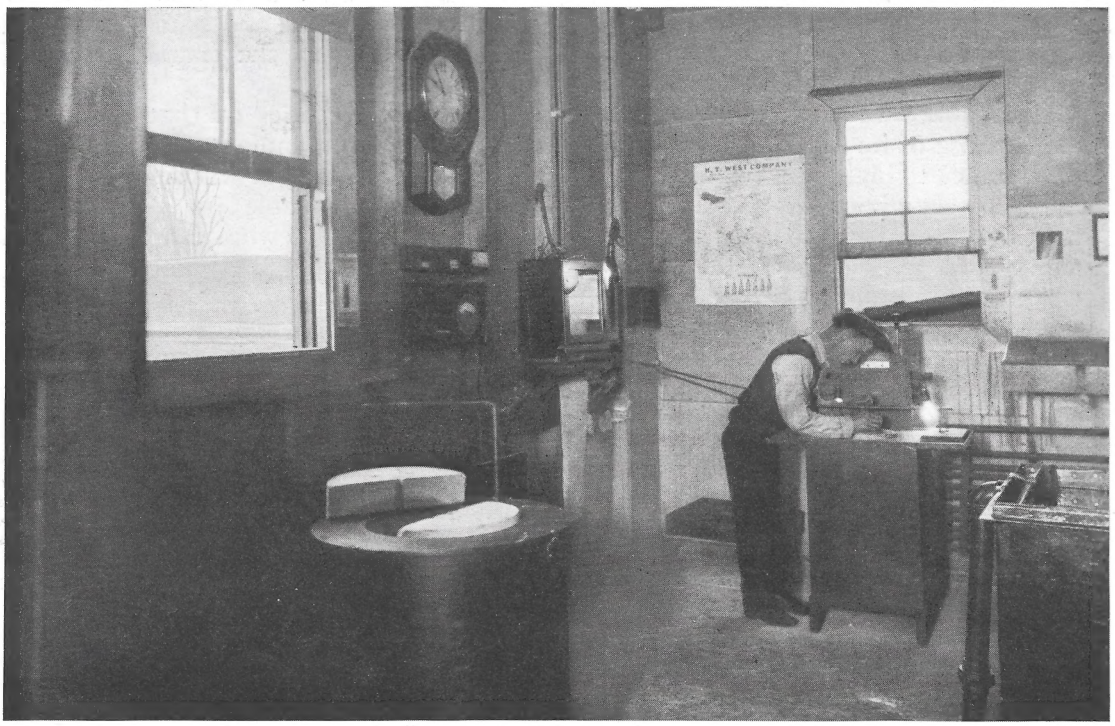


When this Company first began making insulation, thirty years ago, rubber was the basis of all its molded parts, either combined with sulphur in the form of Hard Rubber or Ebonite, or vulcanized with asbestos. We had no apparatus for testing the product and hardly anything was known about the characteristics of insulation.

Very few factories at that time were devoted to the manufacture of insulating materials. The output was small, and the instruments available for testing were crude compared to what can be obtained now.

Since the discovery and application of the Synthetic Resin, molding insulation has become a recognized industry employing a large number of people and turning out millions of dollars worth of product every year. During the past decade the number of patents granted in the United States to ambitious inventors for insulating materials, molds, and methods of making insulation, runs well into the thousands. A number of these inventions have useful applications, but the majority are worth nothing at all.

DRAFTING ROOM



FURNACE ROOM

Steel Molds—Design, and Relation to Piece Price

ALMOST any piece of insulation can be molded. It depends entirely upon the ingenuity of the designer and upon how clearly he can visualize mechanical construction. To design a piece which can be molded commercially at a usable price is quite another problem. The solution of this problem is simplified when the designer of the required piece is familiar with the art of molded insulation. In most instances this is not the case, and it is hardly to be expected. The nearest approach to it lies in cooperation between the engineering department of the customer and that of the maker of molded insulation.

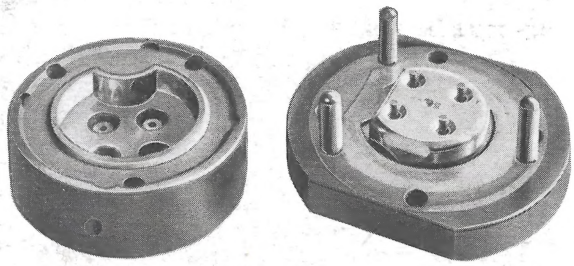
This cooperation should begin with the design of the piece, and can be secured in either of two ways. Specifications, quantity requirements and full particulars as to conditions to be met in service, together with blue-prints giving dimensions and tolerances, may be submitted by the customer to the maker for approval or suggestion.

The other and by far the better way is for the insulation designer to confer directly and personally with our engineering department to determine the best and most effective piece design, both in operation and in cost.

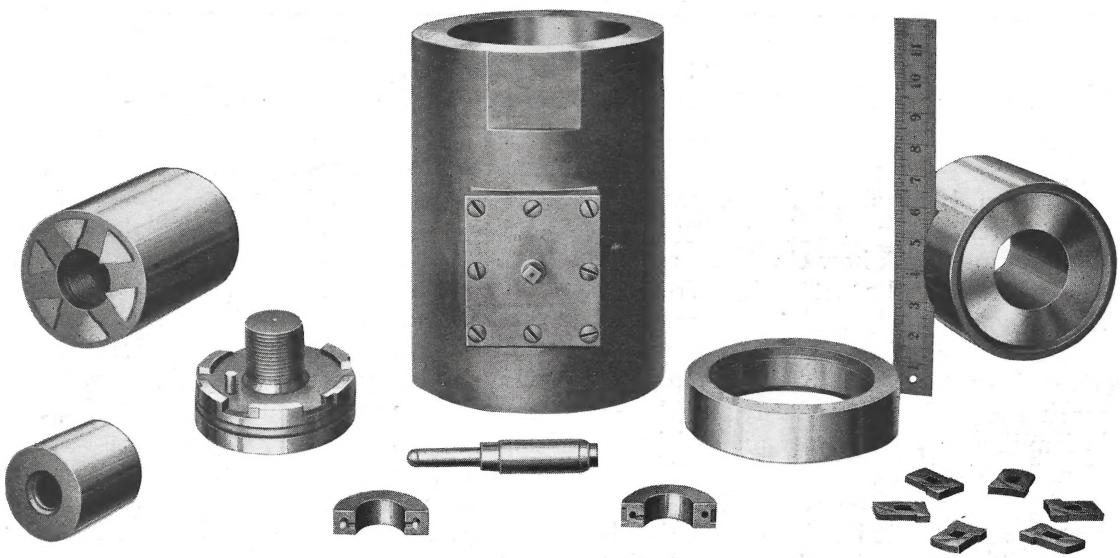
It is by no means unusual for the maker to receive blue-prints showing pieces which it is impossible to mold economically. These "stunts," require intricate molds of prohibitive cost and demand great skill and care to operate. Undercuts, sideholes, difficult location of inserts, etc., can be, in many instances, so modified as to make molding simpler and cheaper, and to reduce greatly the first cost of the molds. Technical advice of this sort is a part of our service.

We guarantee our product. If we accept an order for a piece having a specified accuracy of dimensions, we will build the molds and make the pieces *to that accuracy*, or we will not expect any payment for mold or piece. Our molds are built to last. They are made of steel, hardened and ground. They are of ample proportions. All sections are designed to have sufficient strength to support their portion of the molding pressures. Fits are accurate. Fastenings, where required, are numerous and heavy. Number of parts is reduced to a minimum. Finally, in the design of our molds, we consider first, quality and accuracy of molded pieces; second, cost of molded piece; third, life of mold; fourth, cost of mold. If our prospective customer does not agree with us as to the relative importance of these points, we must regretfully admit that he can buy molds cheaper elsewhere.

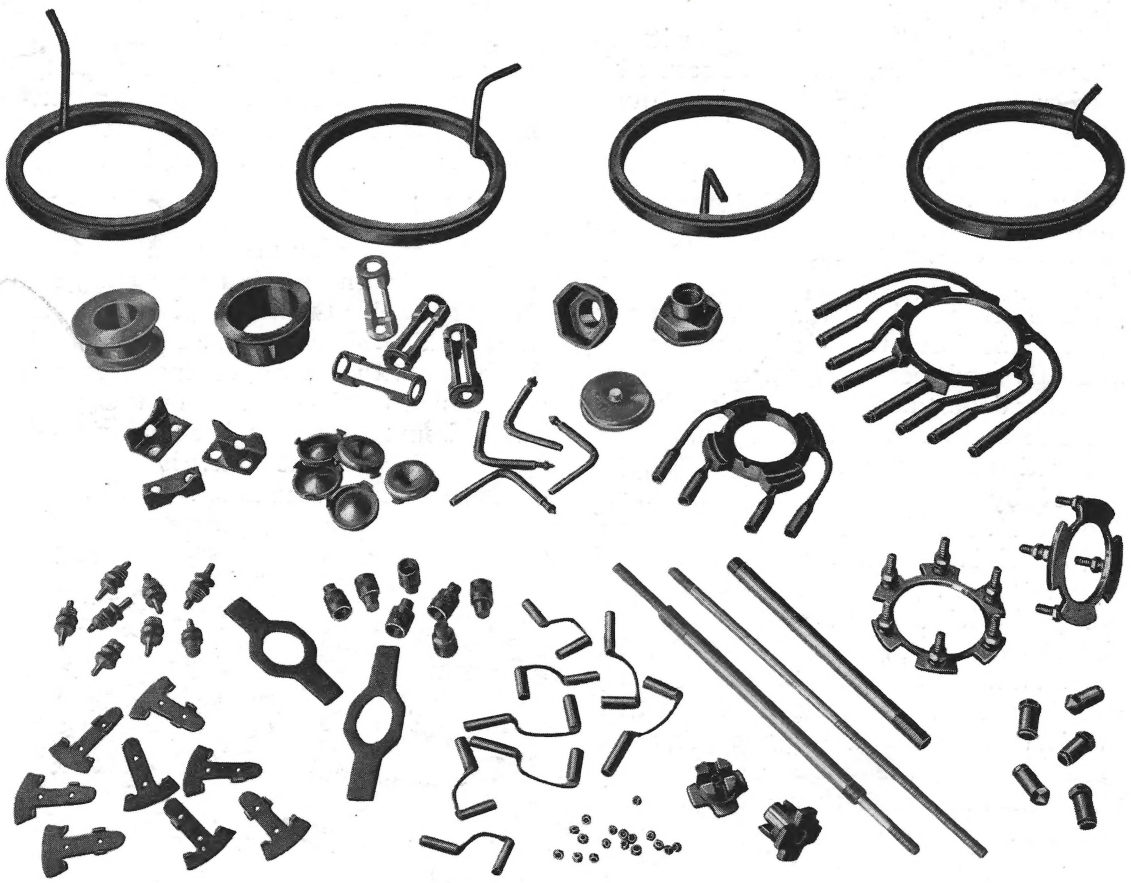
All molds for which a customer pays are his property and subject at all times to his order. Inasmuch as we charge no profit on molds themselves, it is expected that molds which we make will remain in operation with us for a reasonable time, to enable us to realize a profit on the pieces made from such molds. We have no rigid requirements about this, having found such requirements unnecessary.



OPEN STEEL MOLD



COMPLICATED STEEL MOLD



VARIOUS TYPES OF METAL INSERTS

Steel Molds—Design, and Relation to Piece Price

(Continued)

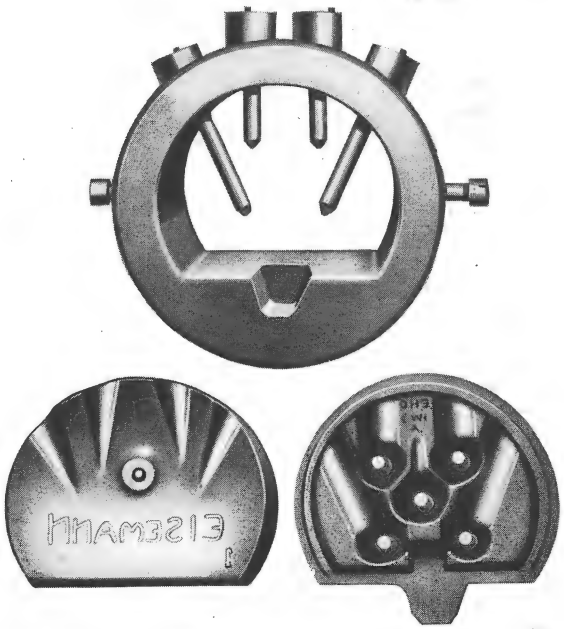
LARGE BAKELITE PIECES

We depend upon the fairness of our customers who have an understanding of the situation, and we are content to rest upon this understanding. Molds are kept in repair without charge to the customer. The item of repairs on molds is a very considerable one and amounts to a great many thousands of dollars each year. Ordinary wear and breakage due to occasional carelessness on the part of workmen can be readily estimated and controlled, but extraordinary wear due to complicated design cannot be anticipated.

During the war it was hard to get phenol at any price and we were obliged to use Bakelite made from cresylic acid. Fortunately the chemical process of purifying phenol results in cresylic acid as a by-product, otherwise we should not have been able to keep our factory running. Unfortunately, due to the changes we were obliged to make in our mixtures, our mold repairs increased alarmingly and almost to a prohibitive figure, and the appearance of the molded product suffered on this account.

We were finally able to produce mixtures which brightened the working surface of the mold and as a result of the work we were forced to do, we are now in a better position than ever before in this respect. However, it is almost impossible to estimate the exact quantity of pieces any given mold will produce before it is completely worn out and has to be replaced. The design, the way in which it is made and the constant supervision over repairs are the controlling factors. All this costs money and it is always well to think of it when comparing one estimate with another.

The design of metal inserts also has its effect upon the ultimate cost of molds, and no service is complete which does not take all of these items into consideration.



STEEL MOLD SHOWING SIDE PINS

RECORDING PYROMETER

Heat Treatment of Steel

THE best mold design, coupled with the most accurate estimating and the most finished toolmaking, can be wiped out by a simple error in hardening. We have long realized the vital character of this process and have in consequence installed the most scientific hardening method available. The equipment consists of two Leeds&Northrup Electric Furnaces, governed by a recording pyrometer of the same make; a circulating oil-quenching bath, water-cooled; and a Tate-Jones Oil Tempering Bath. This equipment is located in a separate building near the tool room and is operated by a man specially trained for our class of work.

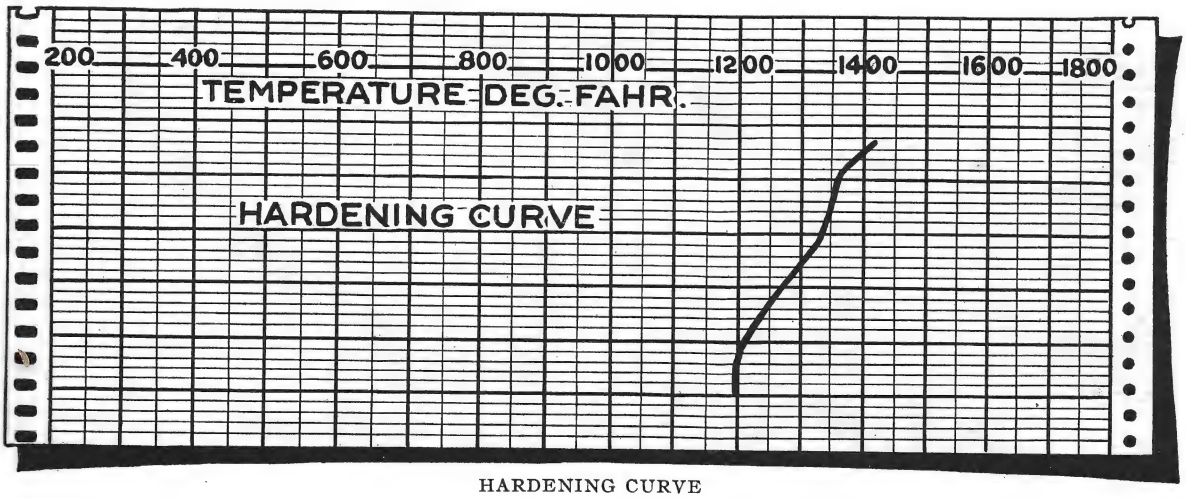
The old methods of personal judgment and eye gauging have been entirely eliminated. The hardening is done with strict reference to the location of the "hump" or decalescence point on the pyrometer chart. Errors of calibration and variable resistances in the connections are thereby made of negligible importance. The steel is left in the furnace a sufficient time after the dip in the curve has been passed to make sure of the change taking place throughout the entire mass of the piece and then it is carefully quenched in the oil bath. Each piece is drawn back to a specified temperature depending upon its function in the mold.

The complete history of the hardening of each mold, including the scleroscope hardness before and after tempering and the pyrometer chart is filed in the engineering department for future reference. At intervals, depending upon the rate of production, every mold is checked against its record and a scleroscope test made. As nothing is left to chance, we are enabled to duplicate the original mold. This we were never able to do under the old process.

The recording instrument is rather a complicated looking device, but is relatively simple and works perfectly.

Molded parts of Boonton Bakelite have been used by the manufacturer of this apparatus where possible at considerable saving over the old method.

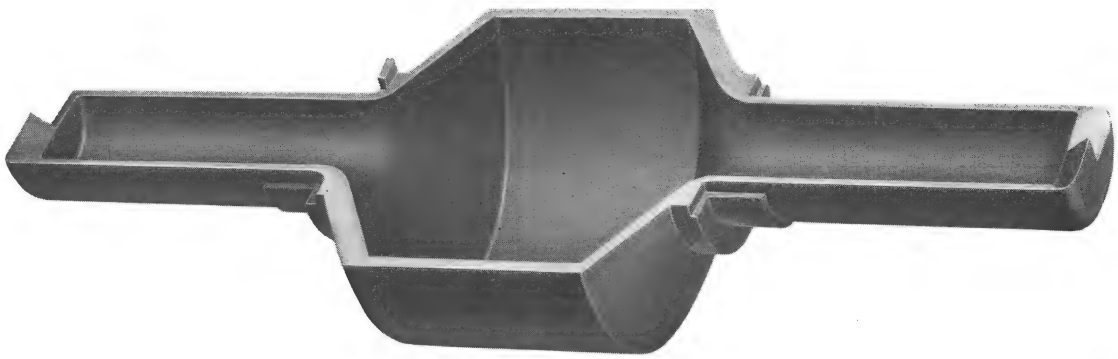
The furnace room is shown on page 6, and the cut on this page shows part of a curve made by the recording pyrometer during the actual hardening of a steel mold.



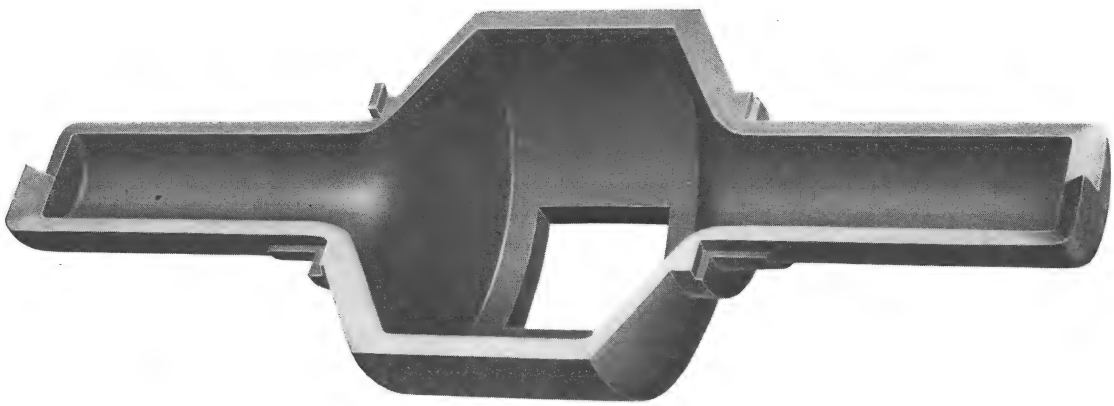
HARDENING CURVE

MILLING AN AUTOMATIC MOLD

GRINDING A HARDENED MOLD



UPPER HALF



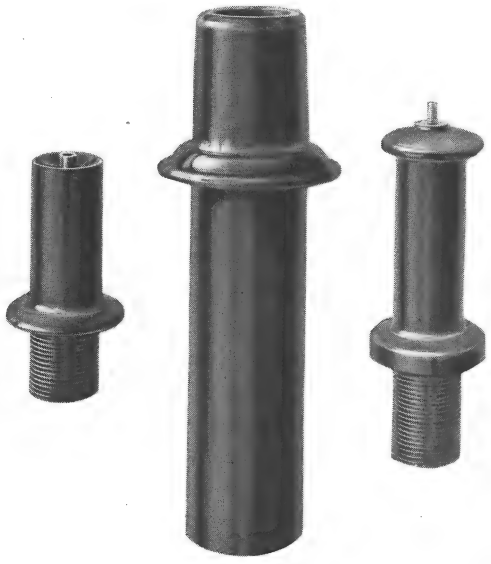
LOWER HALF

COMPLETE SHIELD

Shield for X-Ray Tubes

IN THE use of the X-rays, both for treatment and for diagnosis, it is desirable to cover the X-ray tube with a shield made of material opaque to the X-rays and having an outlet or window just large enough to permit the emergence of a cone or pyramid of rays sufficient to cover the desired area. This is often accomplished by enclosing the X-ray tube entirely in a large lead covered box, and also by holding it in a bowl of lead glass supported by a metal frame, and in various other ways.

Because of the great difference of potential between the ends of the tubes (100,000 volts or more) the use of metal in these tube holders is undesirable, and when lead boxes are used they must be made so large that they are exceedingly clumsy. The lead glass bowls do not completely enclose the tube and, therefore, do not intercept all of the undesirable radiation. Besides this, the glass bowls are fragile and cannot be machined or easily handled.



X-RAY BUSHINGS

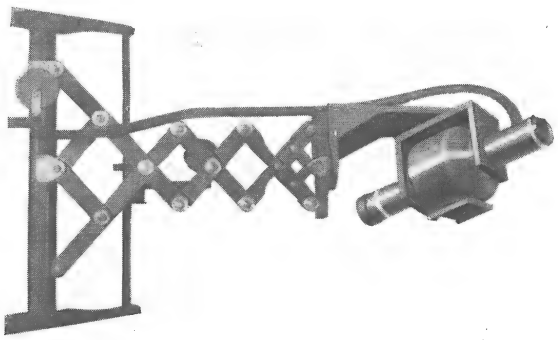
Certain metals aluminum, zinc, platinum, lead, etc., are more or less opaque to the Alpha, Beta and Gamma rays and the oxides of some of these metals have insulating properties when used as fillers with suitable binding materials.

A special Bakelite composition was developed which could be molded at a desirable thickness and still, by selective absorption, prevent the undesirable rays from injuring the operator.

Below we show an improved tube holder in which a Coolidge tube is completely enclosed in a shield of Boonton Bakelite which is opaque to the X-ray and which is a fairly good electrical insulator as well. In order to carry off heat from the bulb, a current of air is drawn through the hose shown. A small aperture on the side allows the useful rays to emerge.

Because the shield is made of insulating material, it can be made relatively very small and light and is, therefore, very much more convenient than the usual type.

Both the holder and the Bakelite mixture are covered by patents taken out by Dr. E. W. Caldwell, whose life was sacrificed as a result of burns received while at work with the old-fashioned apparatus.



SHIELD AND HOLDER

THE MICROMETER IN MOLD SUPERVISION

Accurate Pieces for Scientific Instruments

METER FACE PLATE

THIS meter face plate is molded out of black Bakelite. It is used on the top of a special portable measuring instrument and is very much better than hard rubber, because there is no sulphur in the composition to tarnish the very delicate parts of the instrument. These plates are molded very accurately and have a high polish. Each one has to pass three separate inspections and the slightest imperfection on the surface will cause the plate to be thrown out.

Wood flour has proved to be the most useful filling material for Bakelite when the designer of small apparatus requires molded pieces with a high polish, very accurate to dimension, with metal inserts so located that the tolerance which can be allowed is small.

Bakelite compositions containing wood flour are regularly made in red, brown and black colors, and will stand working temperatures up to 250° Fahrenheit.

Bakelite is the strongest insulation known today and is stable under almost any condition of service. Its electrical properties increase slightly with the rise in temperature up to a given point, unlike other plastic compositions.

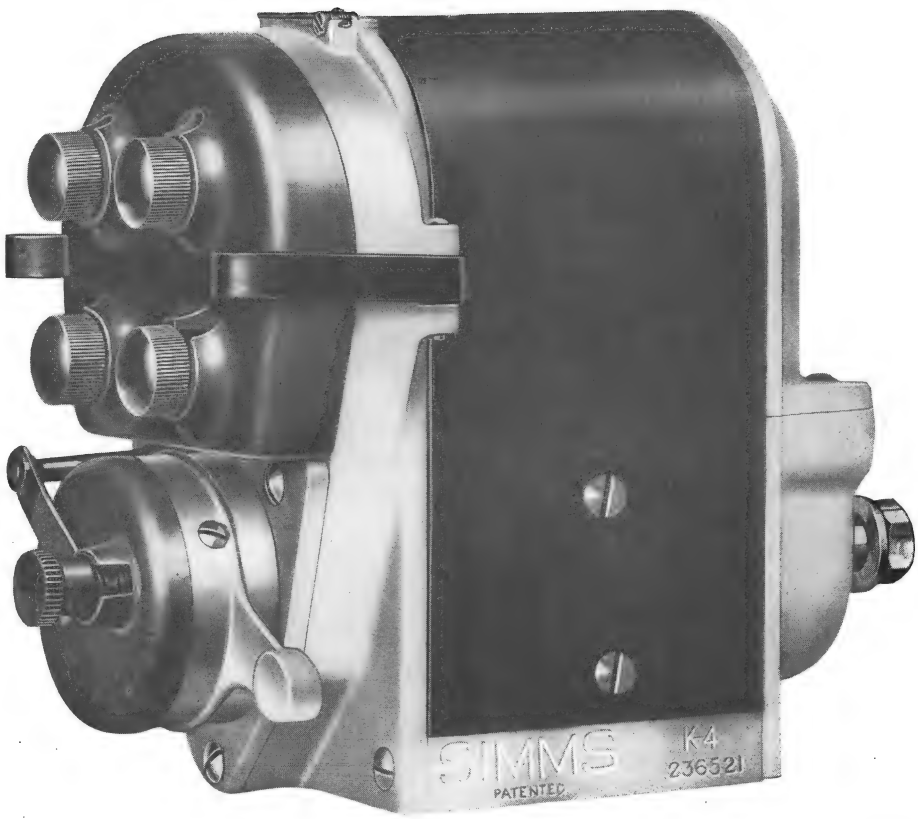
Bakelite has been tried and thoroughly tested for electrical insulation. We were the first to mold it successfully at a price low enough to permit it to be generally used.

We do not claim to compete in price with the punch press and automatic screw machine for small parts of simple design, but where a part is designed in several pieces to be machined easily, we can often mold it in one piece at a considerable saving.

Each piece is an exact duplicate of all others, and is ready to assemble when taken from the mold.

In order to secure the accuracy required, each new mold is carefully measured after it leaves the tool room. Pieces are molded with it in a separate press unit and checked with the drawing for customer's approval, before the mold is allowed to go into actual production. It is part of the duty of our Mold Supervisor to examine and check the molds from time to time while they are being run on orders.

LEEDS & NORTHRUP POTENTIOMETER



SIMMS HIGH TENSION MAGNETO

Rubber

High Tension Ignition

Hi Tensit is a vulcanized product very similar to hard rubber, except that Hi-Tensit has a harder wearing surface and will withstand higher temperatures. Our "Hi-Tensit-72" is molded in steel molds under high pressure and temperature. The pieces are molded ready for use, without the finishing operations formerly required. This material is especially suitable for distributor plates and parts used on high-tension ignition devices for the automotive industry.

Metal inserts containing copper must be tinned to protect the metal from the very small quantity of free sulphur in the material. This is desirable on all designs which require the segments to be ground even with the Hi-Tensit to provide an absolutely smooth surface.

The color of this material is usually red-brown or black, and is very often used with Boonton-Bakelite on the same piece. It is always used where protection against carbonization is the first consideration.

Seven years of actual service has proved that Hi-Tensit has no equal for distributors of the rubbing contact type. The electrical and mechanical strength of the material, its ability to withstand wear uniformly by contact with a moving carbon brush, are all factors of the utmost importance in designs of this character.

Carbonizing Test

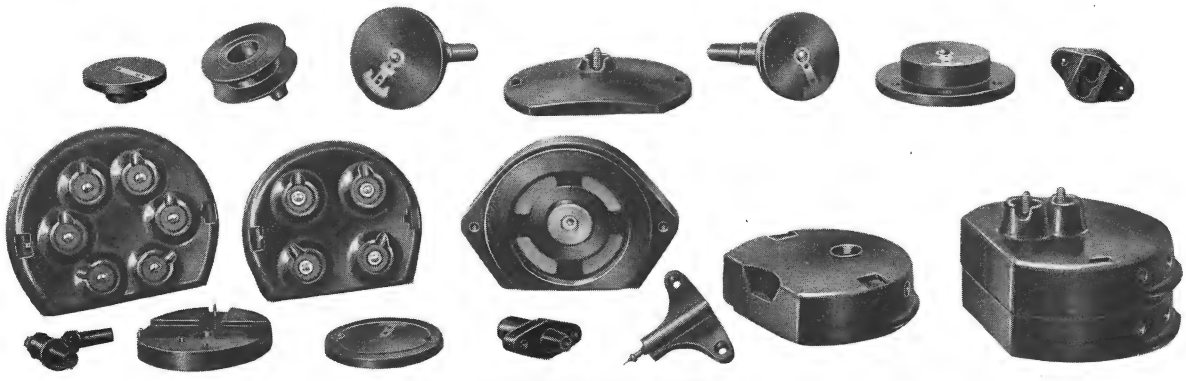
Current from a high tension magneto at 2,500 r.p.m. or from a low tension magneto and coil, is led across the surface of the sample, between needle points, until the spark carbonizes the material. A fixed gap of 10 mm. is connected in parallel with the variable distance between the needle points.

When the resistance of the carbonized path becomes high enough the spark will again jump across the 10 mm. gap. The length of the carbonized path is measured and divided by the length of the air gap. The result can be used as an index for the different materials tested.

The index value of "Hi-Tensit-72" compared with hard rubber and Bakelite compositions by the above method is shown in this table:

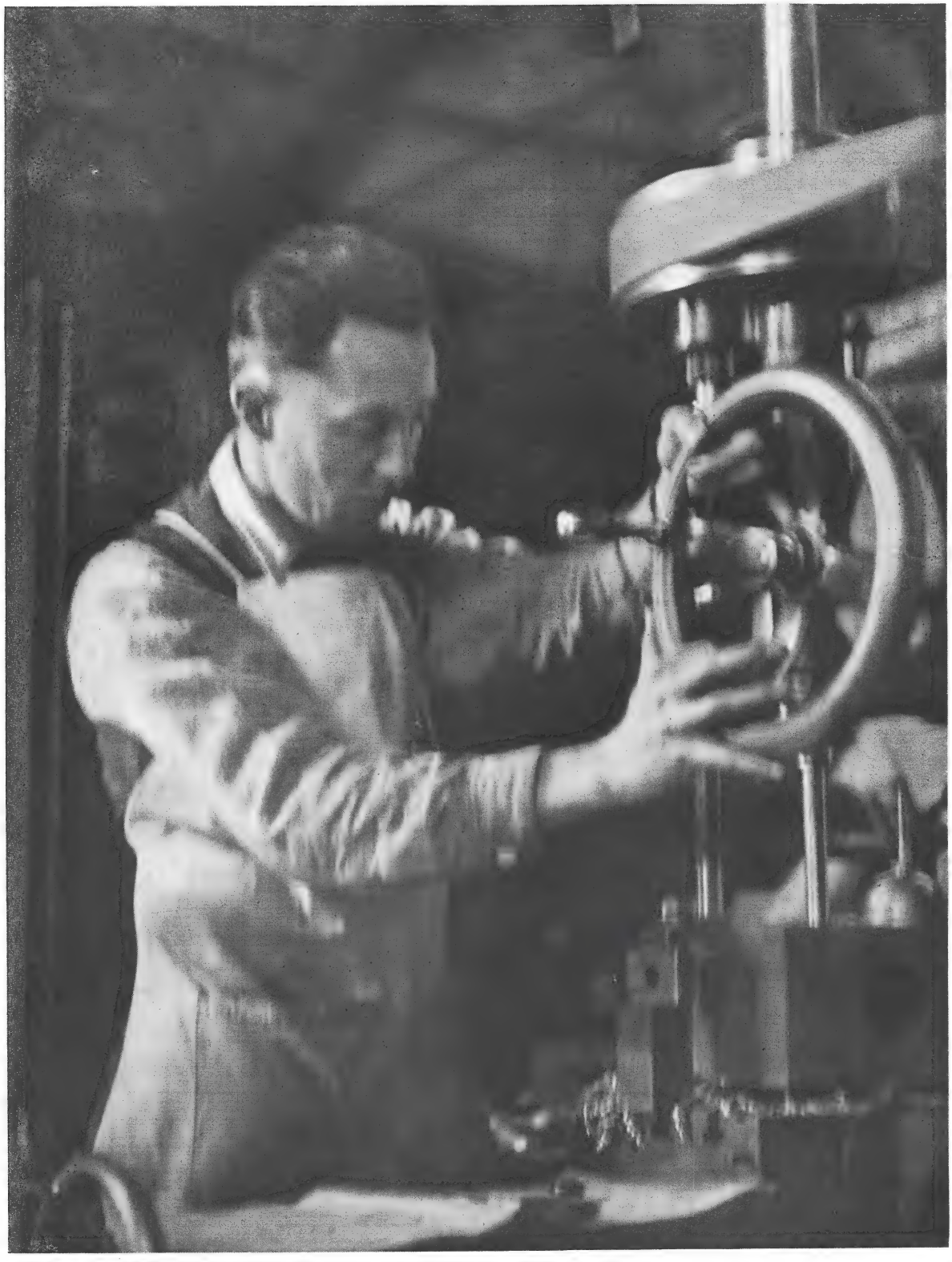
Material	Index
Hard Rubber	1.4
Hi-Tensit-72	3.2
Bakelite Asbestos	5.6
Bakelite Wood-flour	15.5

Air gap 11.9 mm.=
Approximately 10,000 volts.



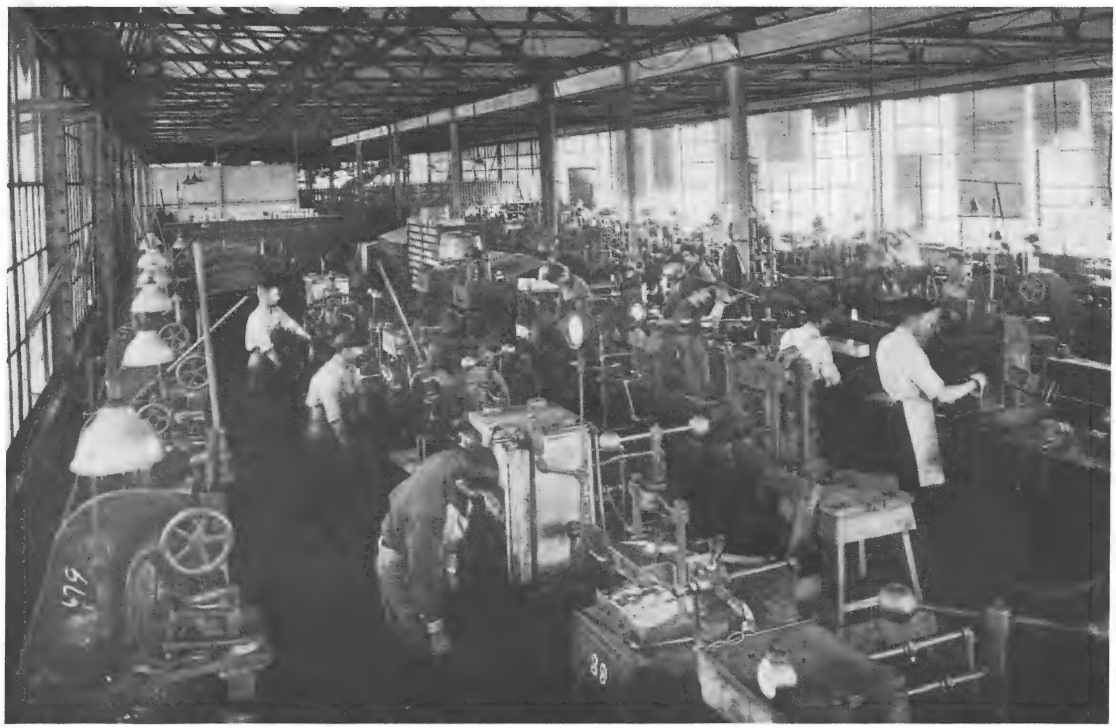
DISTRIBUTOR PARTS

ROTARY TABLE MILLING

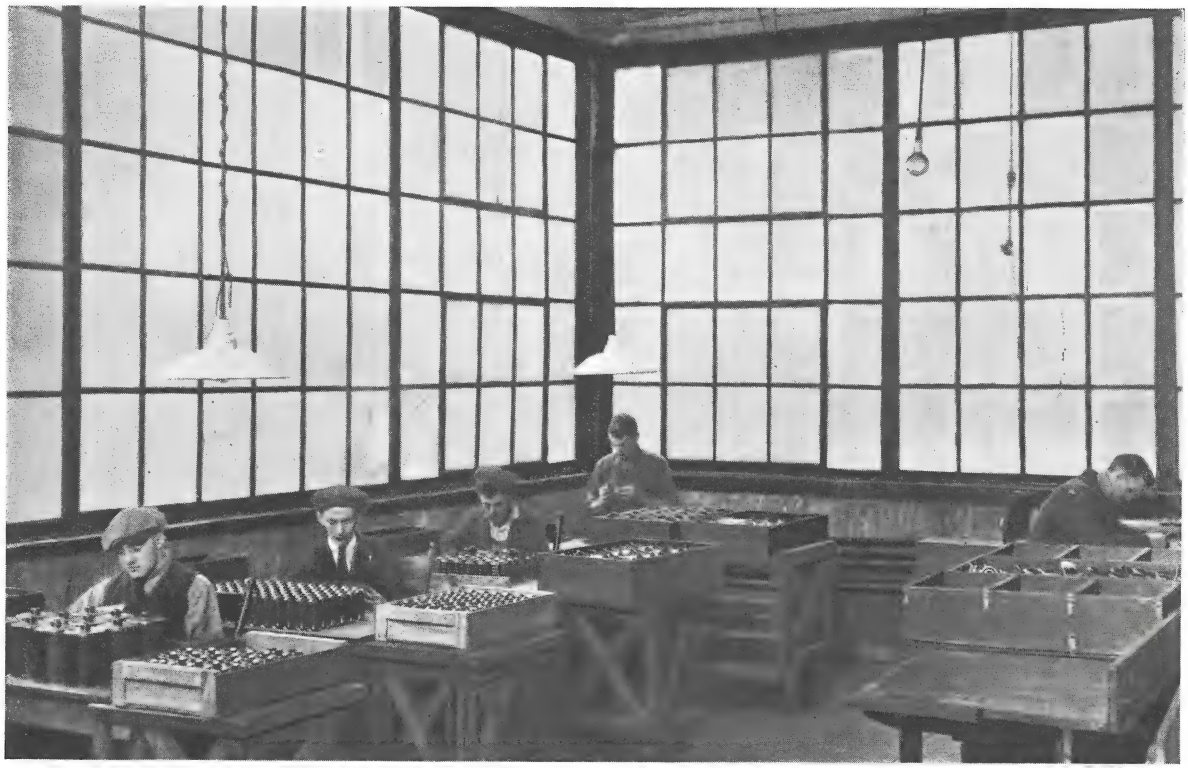


BORING WITH THE MILLER FOR ACCURACY

TOOL ROOM

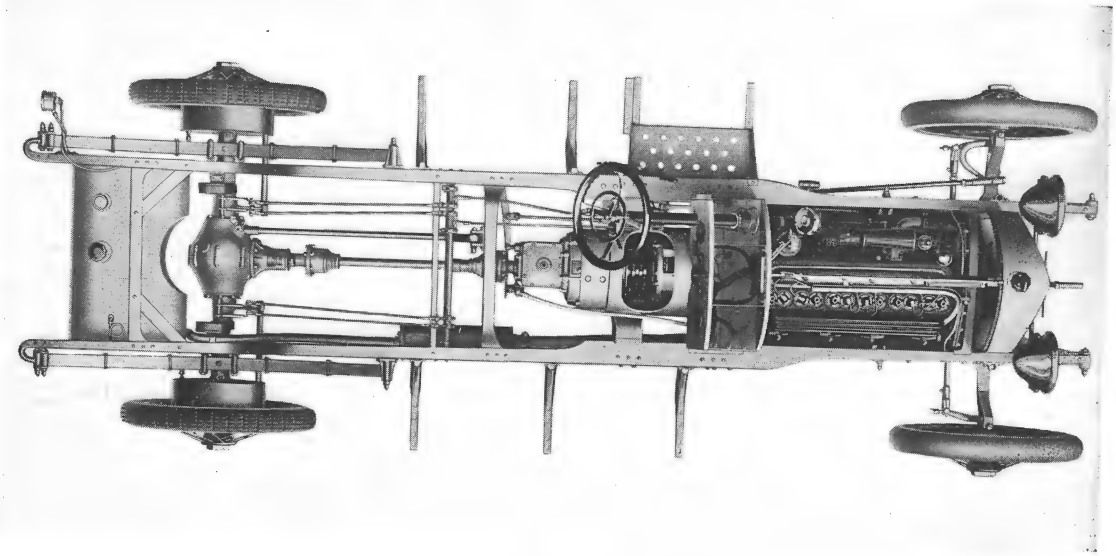


HYDRAULIC PRESS ROOM

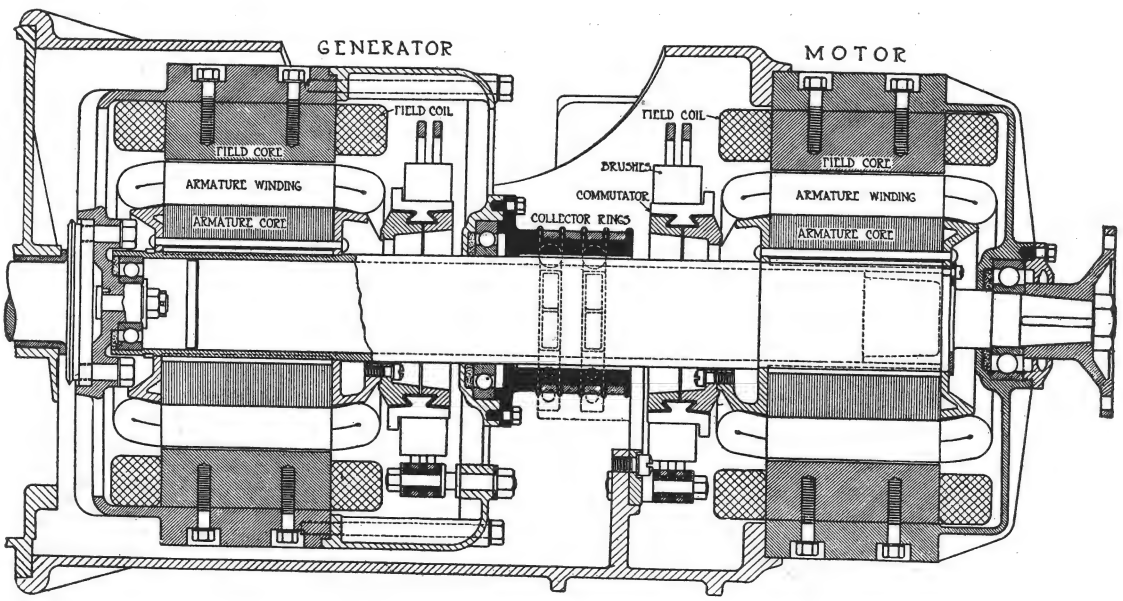


INSPECTION

FINISHING DEPARTMENT



CHASSIS OF THE "OWEN-MAGNETIC"



ENTZ TRANSMISSION

"BOONTON BAKELITE is used in the construction of paddles or agitators in the treatment of water and sewage by electro chemical means, particularly in the Landreth Direct Oxidation Process. This process is based upon the fact that water when decomposed by the electric current liberates oxygen in an active form and if utilized before it becomes gaseous oxygen, it acts as a powerful deodorant and germicide.

"In this process lime is added to neutralize acids and to furnish a medium, $Ca(OH)_2$ for the passage of the electric current. The nascent hydrogen and oxygen thus liberated are availed of for the destruction of objectionable odors, bacteria and bacterial foods in water or sewage.

"This caustic lime permits the use of steel for the electrodes. The standard units have twenty-two banks of electrodes, each having forty-eight plates, ten by sixteen inches, connected in parallel to give a large conducting surface, and each of the twenty-two banks are seriesed one with the other. The plates are spaced three-eighths of an inch apart, and between these are rotated Bakelite paddles. These keep the passages clear and bring all parts of the liquid into intimate contact with the surfaces of the plates in order that nascent oxygen and hydrogen may be utilized.

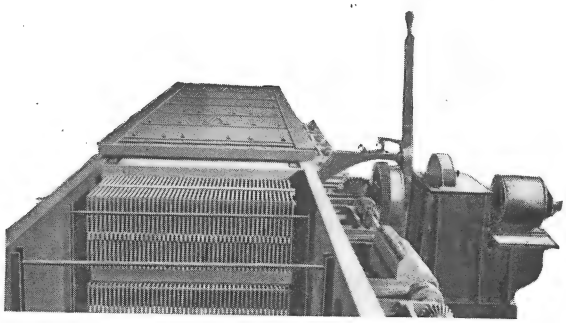
"Bakelite is not affected by the acids of the sewage nor by the alkali, but it is an insulator. Some two thousand of these paddles are used in each standard unit for the carrying out of this direct oxidation process."

The above description was contributed by Mr. C. P. Landreth.

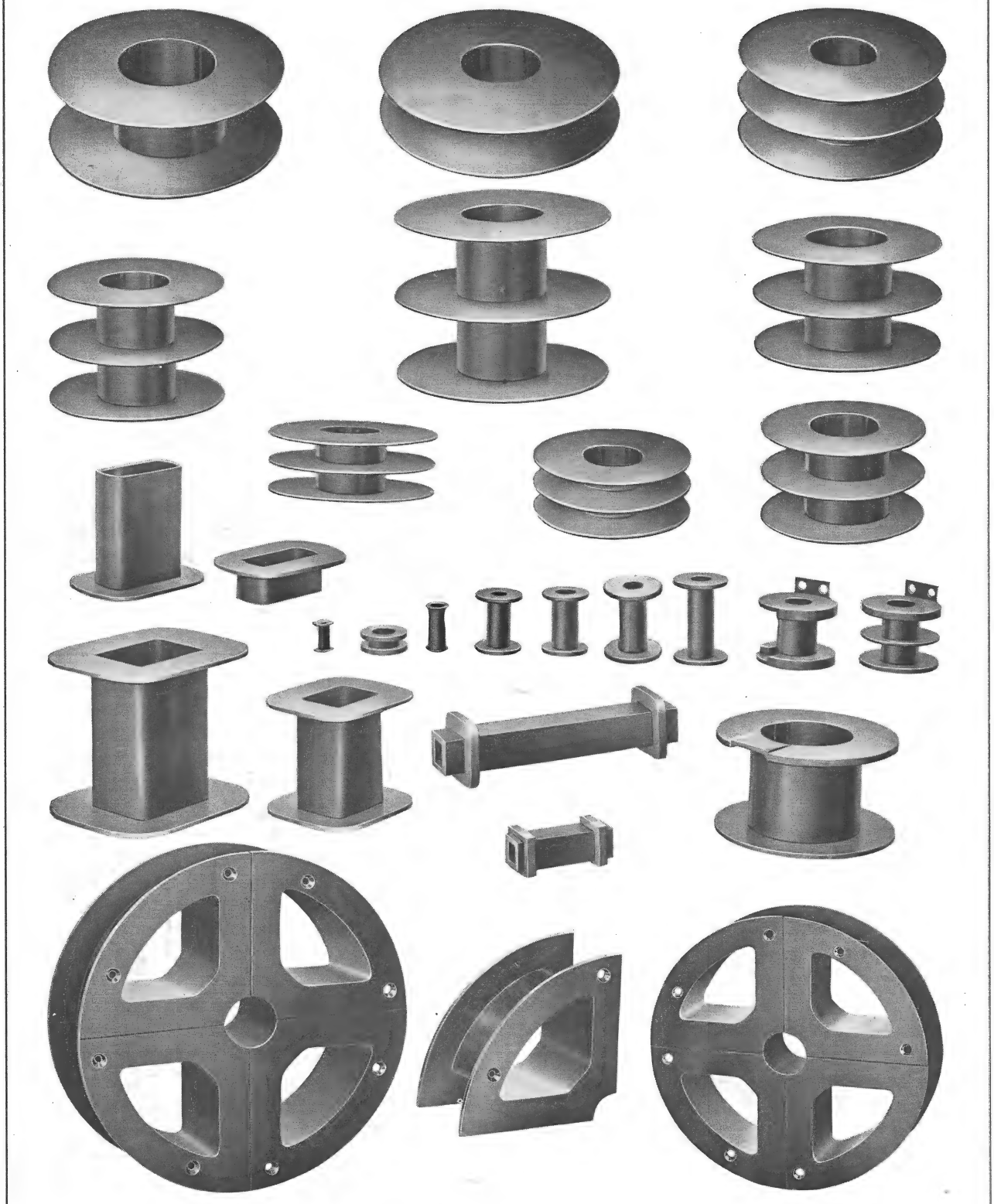
BAKELITE PADDLE

Bakelite collector rings are used on the Entz transmission system. The collectors are seven inches in diameter at the flange and weigh about six and a half pounds. This typifies the solution of a number of special molding difficulties. The large Shelby tube which makes up the inner surface and the four copper rings, each with its separate copper lead, must all be absolutely concentric and all thoroughly insulated.

That our products have stood up in a remarkable way over long periods of service is due almost entirely to our ability to control our own mixtures. This is an essential part of our engineering service.



TANK FOR ELECTROLYTIC PURIFICATION



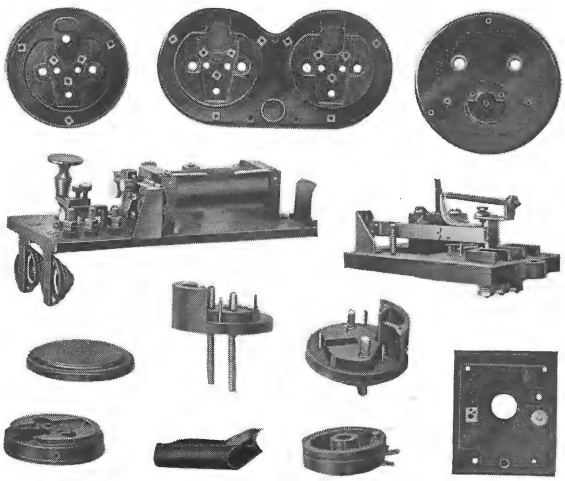
THIN-FLANGED SPOOLS

One-Piece Spools

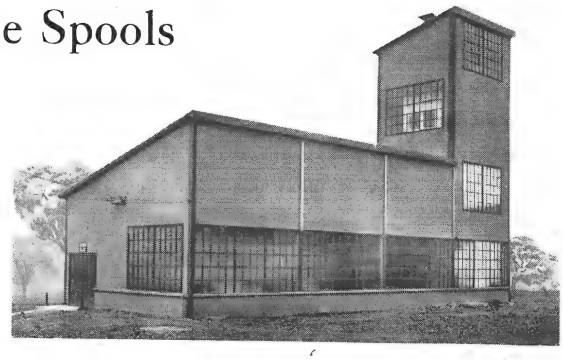
BOONTON BAKELITE spools with thin flanges give the maximum winding space, have the necessary mechanical and electrical strength, and are not heavy. Spools molded in one piece are less expensive than those which are built up out of tubes and washers and should always be used where moisture is present.

It often happens that large spools are required of such design that it is more practical to mold them in quarter sections which dovetail together. This method of molding retains the desirable characteristics of the one-piece spool, and yet the assembly is entirely different from the so-called built-up spool. Many designs can be molded in this way which would be impracticable if the entire spool had to be molded in one mold.

During the past ten years we have made quantities of washers and other parts, using filling material in sheet form coated with Bakelite as the binder and molded in heated steel molds under heavy pressure. Washers for resistance grids are made of asbestos by this method which



BAKELITE PIECES WITH THIN WALLS

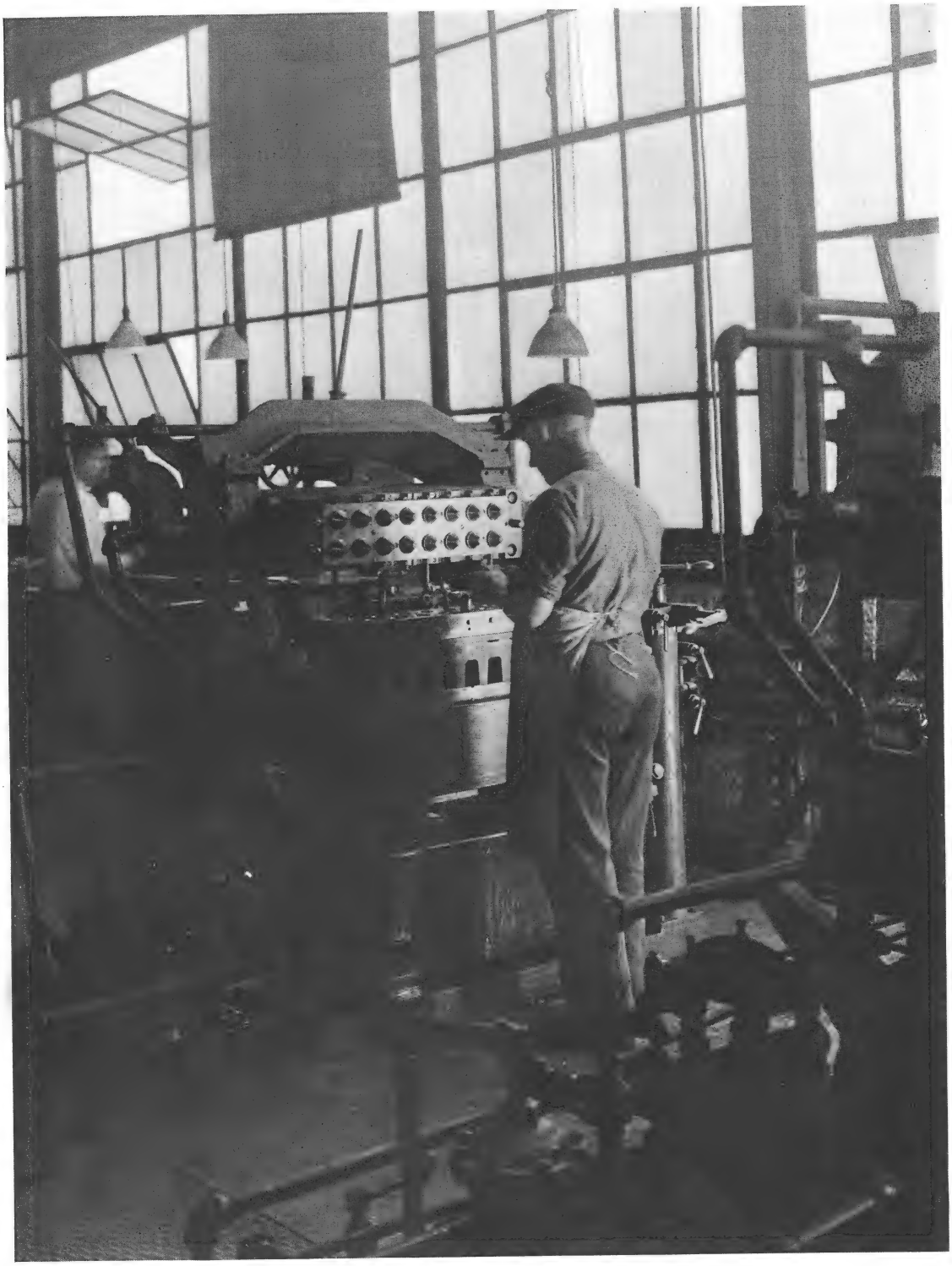


COATING TOWER

stand higher temperatures and are more satisfactory in many other respects than they would be if molded by the regular method. Gears, with molded teeth, are made of special fibre, coated with Bakelite, laminated under pressure in this way.

Large molded parts are often designed with very thin walls, and another useful application of this laminated product is the reinforcing of these walls by inserting a strip of it in the mold along with the molding mixture and molding both at the same time. There are many parts which can be molded in no other way, without a high percentage of rejections.

The sheet material which is the basis of this laminated product, is coated with Bakelite varnished by special machinery in a building designed for the purpose. The coated material is heat-treated, cut or punched to shape or form desired, and then molded under heat and pressure in steel molds in about the same way that the Bakelite composition is molded. It is difficult to mold inserts in place by this process, and thin, flat objects are about the only ones which can be made entirely of this laminated material without the use of Bakelite composition as part of the finished product. The demand for this class of material is increasing and we are equipped with the special machinery to produce it in quantity.



ONE OF OUR AUTOMATIC MOLDING PRESSES

Rubber

Molding with Automatic Presses

THE quality of molded parts, in mechanical strength, dielectric and in finish, depends upon two factors: first, the quality and design of the mold; and second, upon the proper application of uniform pressure and heat to all impressions in the mold.

Disregarding the first factor as obvious, the application of pressure and heat is controlled largely by the number of cavities in the mold. These may be numerous in the case of some small parts, while others admit of only one. It depends both upon the design and upon the size of the part.

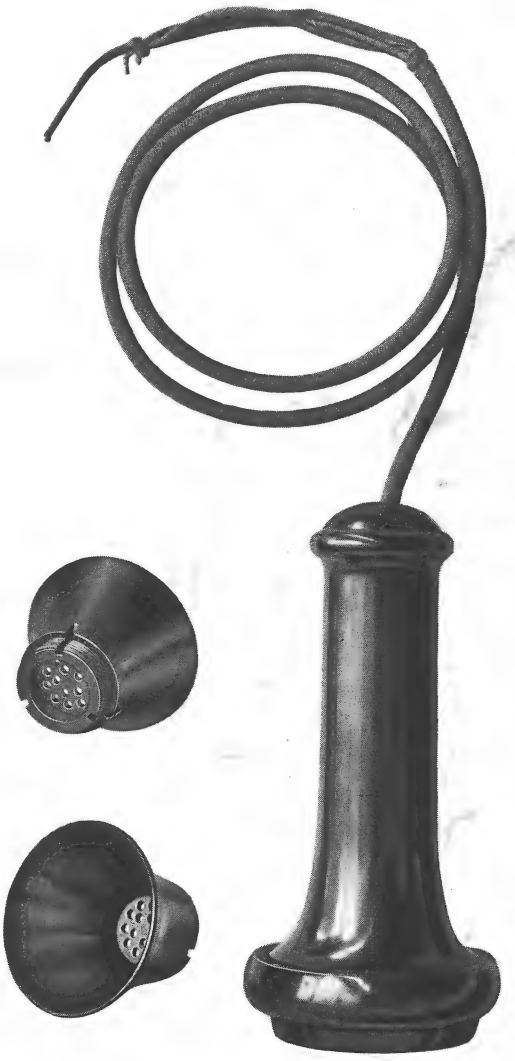
As a rule the single-cavity mold is the best unit to work with, having the advantage of insurance against interrupted production when a mold, one of several, has to be taken out for repairs.

For many years we have been content to let our friends in the molding business use semi-automatic presses with multiple impression molds because it was apparent that quality was being sacrificed to speed and quantity. Nevertheless we have kept at work on the problem till our experiments and experience with this type of press has brought us to the point where we can undertake to produce a quality product in quantity where the design of the part permits this method to be used.

Quantity production depends upon capacity of mold equipment and thus controls price, but where quality parts are required, and we make no other, the mold equipment must be divided into units, no one of which exceeds the limit of perfect parts from the mold.

A four-cavity mold from which two parts have to be thrown out is no better for production than a two-cavity mold with 100 per cent. good parts, and the cost of molds to the customer is twice as great in the first instance as in the second.

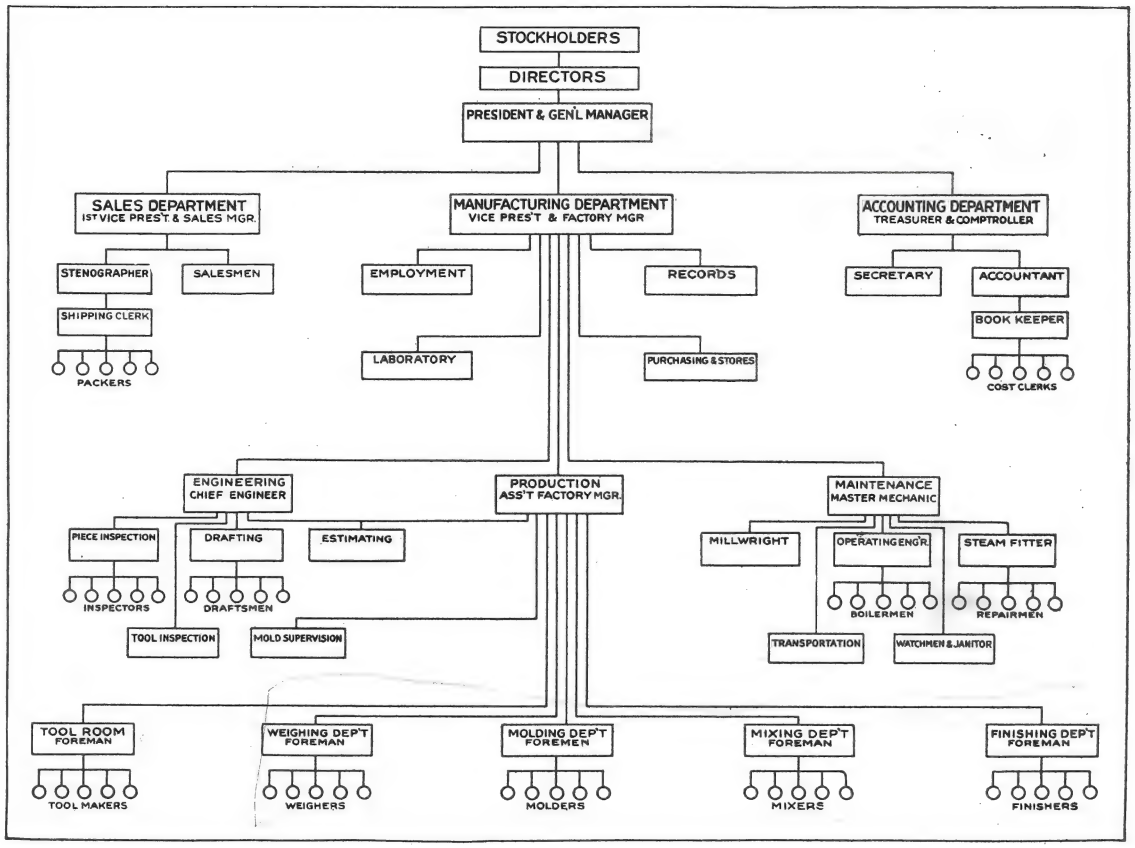
What we need to know in figuring mold equipment is, how many will be required per week and for how long. We can then figure on an economic unit of production, keep mold costs at a minimum and assure the customer of dependable deliveries in quantities promised.



TELEPHONE PARTS

FILLING THE MOLDS

REMOVING FINS



ORGANIZATION CHART

THIS business was founded thirty years ago by Mr. Edwin A. Scribner, who invented a process of reclaiming rubber which was used extensively in manufacturing hard rubber. The corporation began business under the name of Loando Hard Rubber Company, and after about twenty years, discontinued reclaiming rubber and built a new plant devoted entirely to molding insulation of Bakelite and other materials.

The company has authorized capital of six hundred thousand dollars under the laws of New Jersey, and its stockholders are actively engaged in and control the business. No stock is owned or held by other corporations, directly or indirectly.

Our plant is located in Hanover Township near Boonton, New Jersey, on the main line of the Lackawanna Railroad, thirty-one miles from New York City. This location makes it possible to get quick deliveries by freight to all points west of Buffalo and allows of local delivery by truck to points near New York.

The factory is all laid out on one floor of about 50,000 square feet of floor space. The buildings are of modern construction, with plenty of light, and about fifteen acres of land are available for future develop-

ment. The power plant supplies heat, light and power for manufacturing purposes, and besides this the public service provides a second source of supply of current for additional power and in case of emergency. An artesian well supplies water for manufacturing and the city provides a supply to be used for protection against fire. The equipment is modern and is kept up to date with the one idea, always uppermost, in the mind of every individual in the organization to give and to maintain service to our customers.

Boonton is a small town and an old town. For this reason it has many industrial advantages. The type of man at work in the factory would not be satisfied to work in large cities; he is healthy and industrious, is permanently established in the community and has some responsibility.

Our organization chart is simple and it has brought about the closest kind of cooperation between the men who have to work in the office and the men who work in the shop. Some of the men who began to work for the company when it was founded are with us today, and service records of from three to five years are the rule rather than the exception. Many of the toolmakers have been with the company ten years.

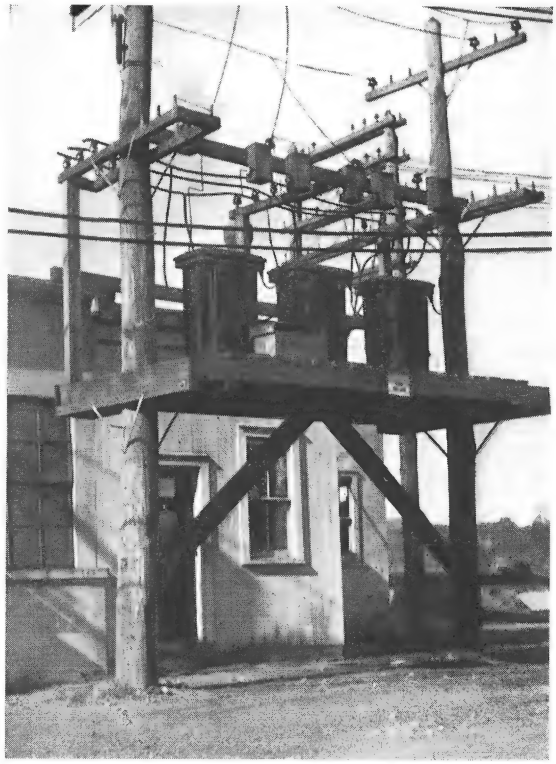
HANOVER BASE BALL TEAM

The Hanover Baseball Club represented the town of Boonton as well as the company this year in the Four County League. With but a single exception, the members of the team have been with the company for over three years, and the spirit of team work is just as apparent in the factory organization as it is on the field.

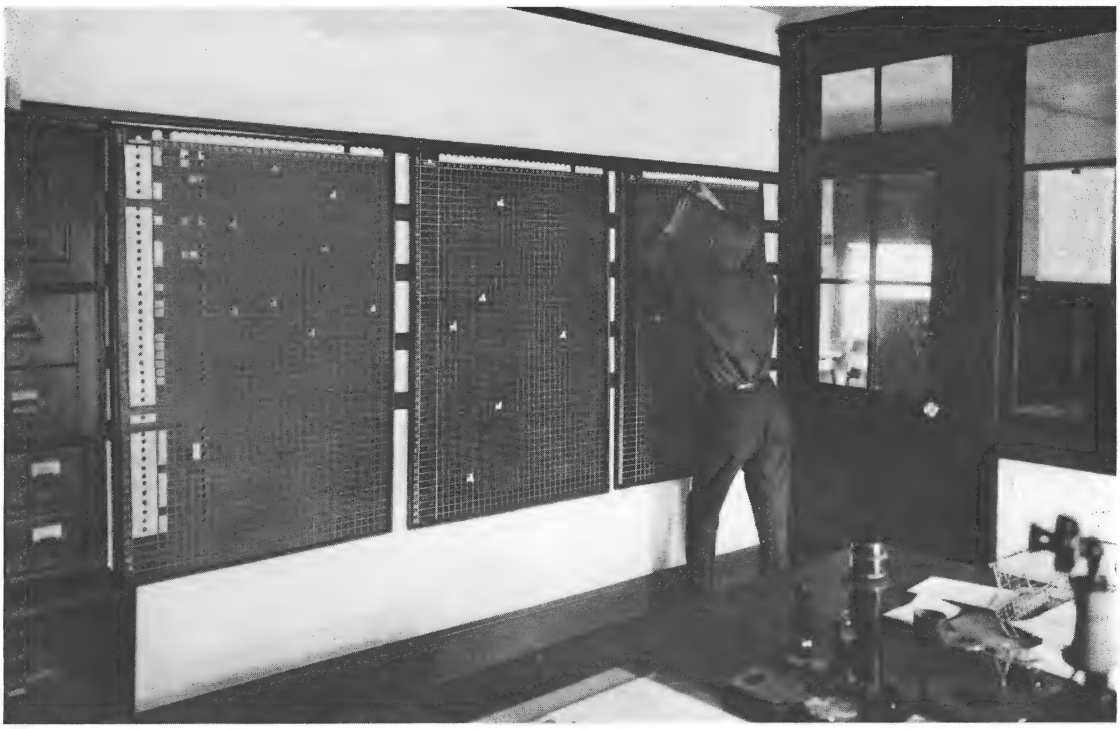
Our policy is to try to get every man to take an active interest in his own particular job. Results justify our belief that we are making progress in this direction.

We know that every man in our organization has enough work to do, whether he does it in the factory or office.

Waste has been eliminated and processes improved. Our production per man per press unit has steadily increased, with a corresponding decrease in the price of our product.



AUXILIARY CITY POWER



PLANNING DEPARTMENT

SHIPPING DEPARTMENT

Insert Supply Effect Upon Production

BUYERS of molded parts often fail to realize the effect of insert supply upon production and costs.

Where an order is large and inserts are provided at regular definite intervals in quantities sufficient to keep molds in production, costs are kept down and deliveries are dependable. Where the order is small and inserts are provided to cover the full number of parts before production begins, the result is the same.

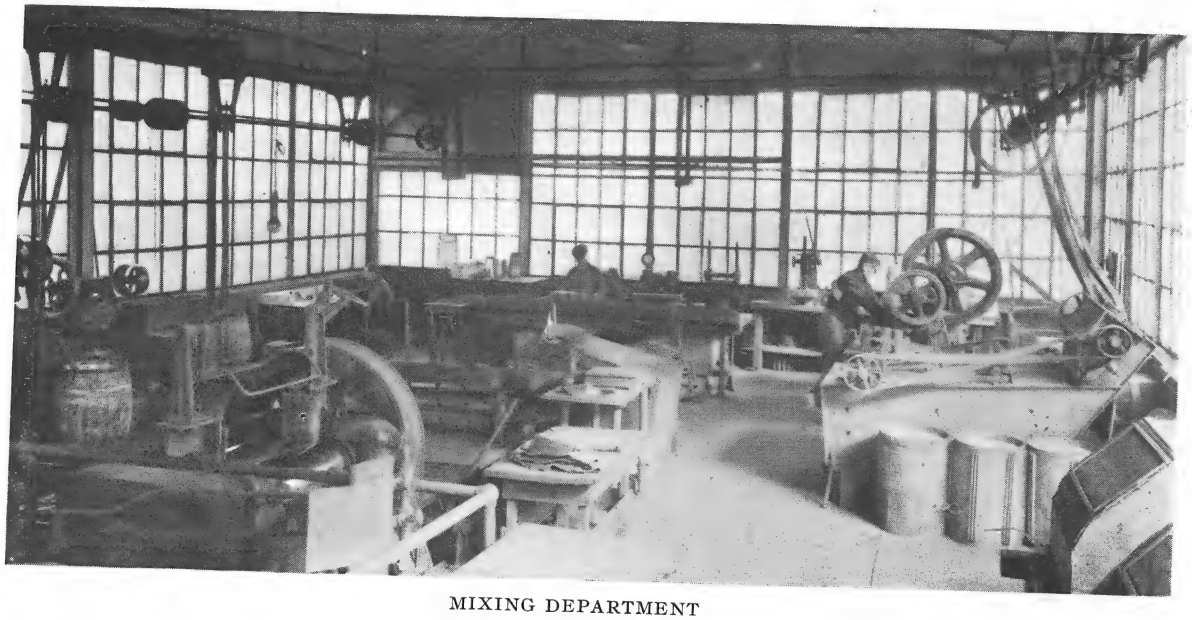
Interrupted production means waste and consequent loss, which must be borne either by the customer or supplier. No matter who bears it, waste is waste, and is inexcusable. The most important factor in business prosperity is high production.

There is no one cause which tends so much to hold prices at a level above normal as interrupted production. The facility which a molder acquires from familiarity with his work is lost, repairs to molds are frequent, spoiled parts multiply, and cost of inspection increases. The buyer who fully realizes this and accepts his responsibility for continuous production gets the benefit of the lowest prices and of the best service generally.

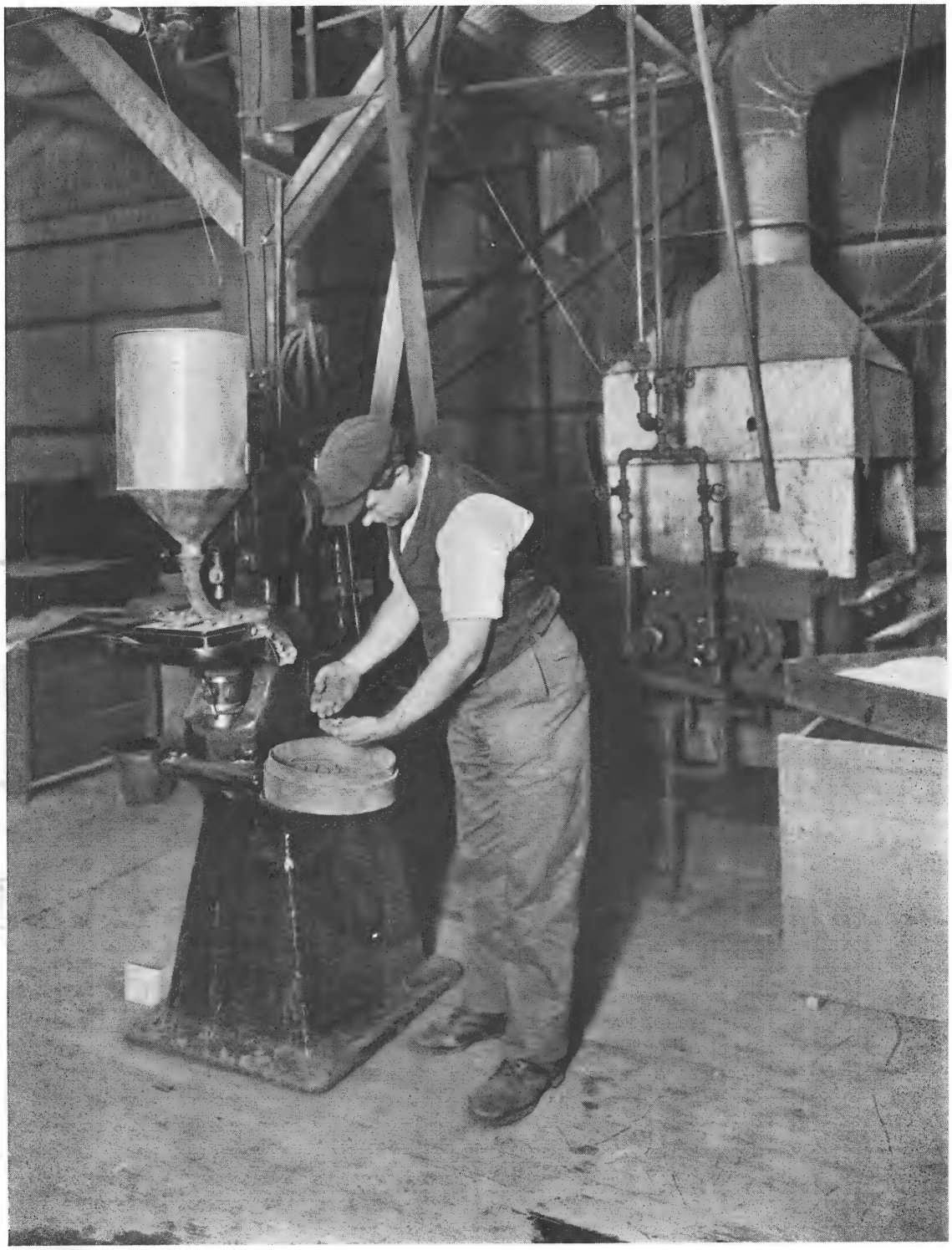
The supplier of molded parts which require inserts should provide for at least three weeks' supply at all times. If he will add to this, careful inspection of these inserts before they are shipped, both quality, delivery and cost will be improved.

We can and do mold parts as cheaply as anybody and we have never asked, nor do we expect to receive more than a fair profit. The service we render in addition to molding the parts is the most important and valuable thing that our customer buys. It is not so much what he pays as what he gets. Our own percentage of profit is smaller with service than without it, but the total net income of the business is greater.

When orders are placed for parts from a new mold, an allowance for spoilage should be made.



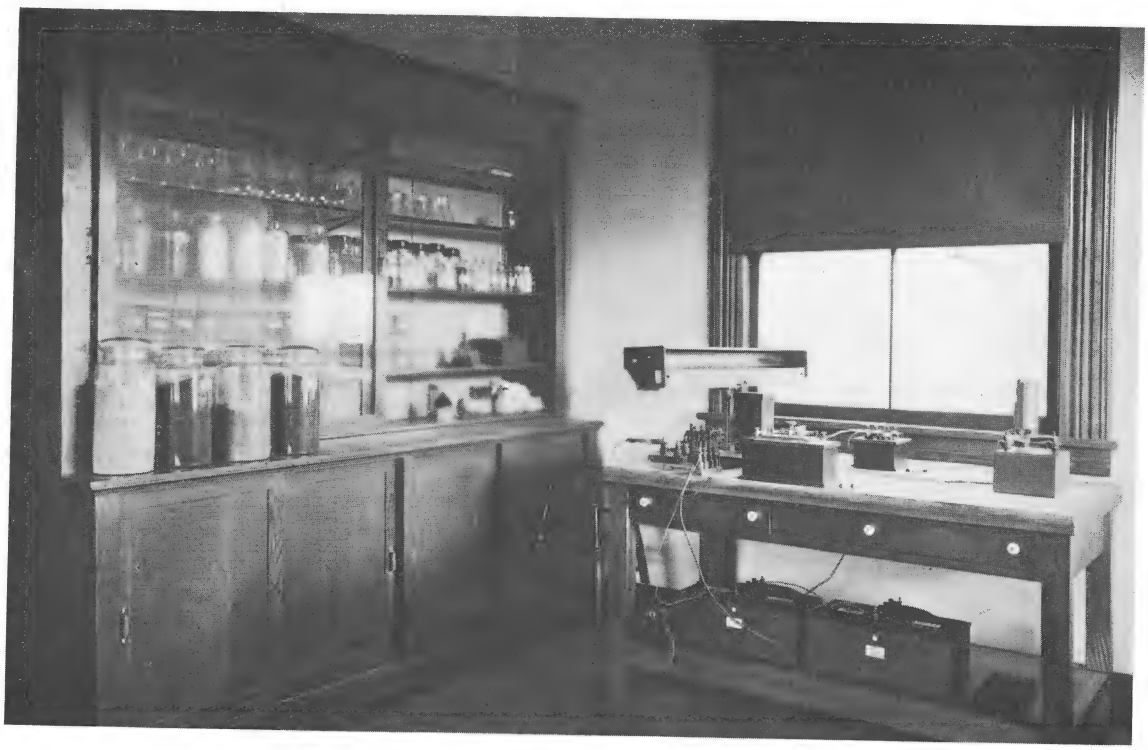
MIXING DEPARTMENT



AUTOMATIC PELLET MACHINE

AUTOMATIC WEIGHING MACHINE

CHEMICAL LABORATORY



INSTRUMENTS FOR MEASURING HIGH RESISTANCE

Technical Control of Mixtures

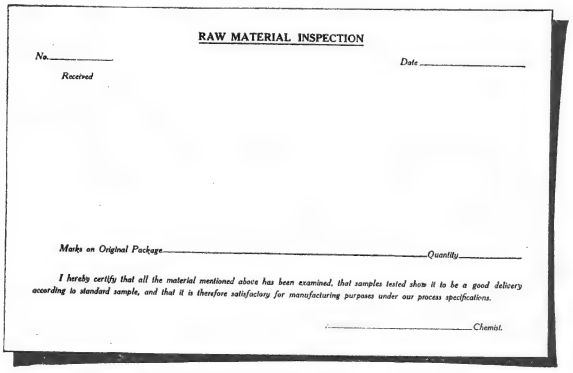
OUR manufacturing methods and the technical control of the product are all reduced to written process specifications, which consist of a very complete description of the way the material is made and a separate engineering report of how the product behaves under certain standard tests. Nothing is left to the individual or a group of individuals, and delivery does not depend entirely upon foremen who under the old system were often required to carry the necessary information in their heads or in pocket memorandum books. The company makes the same product, regardless of changes which may occur in the organization from time to time. This is a kind of insurance which our customers are glad to get as part of our service.

A close check is kept on all material which goes into our product and this control is tied into our purchasing records in such a way that price is not always the determining factor in keeping the factory well supplied with raw materials.

The control of filling weights is an important part of the molding process and we are always developing special machinery to give accurate weights automatically and continuously. When the material is weighed out by hand, great care must be taken to insure constant and accurate filling weights. Otherwise, many pieces are spoiled in molding, which would under proper conditions pass the preliminary bench inspection. Accurate weights are very necessary for quality, in quantity production.

Naturally, during a period of thirty years we have had to mold insulation in about every possible shape, and experience has taught us that no mixture is satisfactory, no matter how many laboratory tests have been made on it, until it demonstrates its value under actual service conditions.

It sometimes happens that a material is right but the design is wrong. We are anxious to help our customers in the study of piece design, because we believe we can point the way toward greater simplicity, which is always desirable in the interest of lower cost and a higher rate of production. This is perhaps the most important feature of the service we are prepared to give you, especially when it is coupled with prompt delivery of the molded parts.



RAW MATERIAL INSPECTION

No._____ Date_____

Received

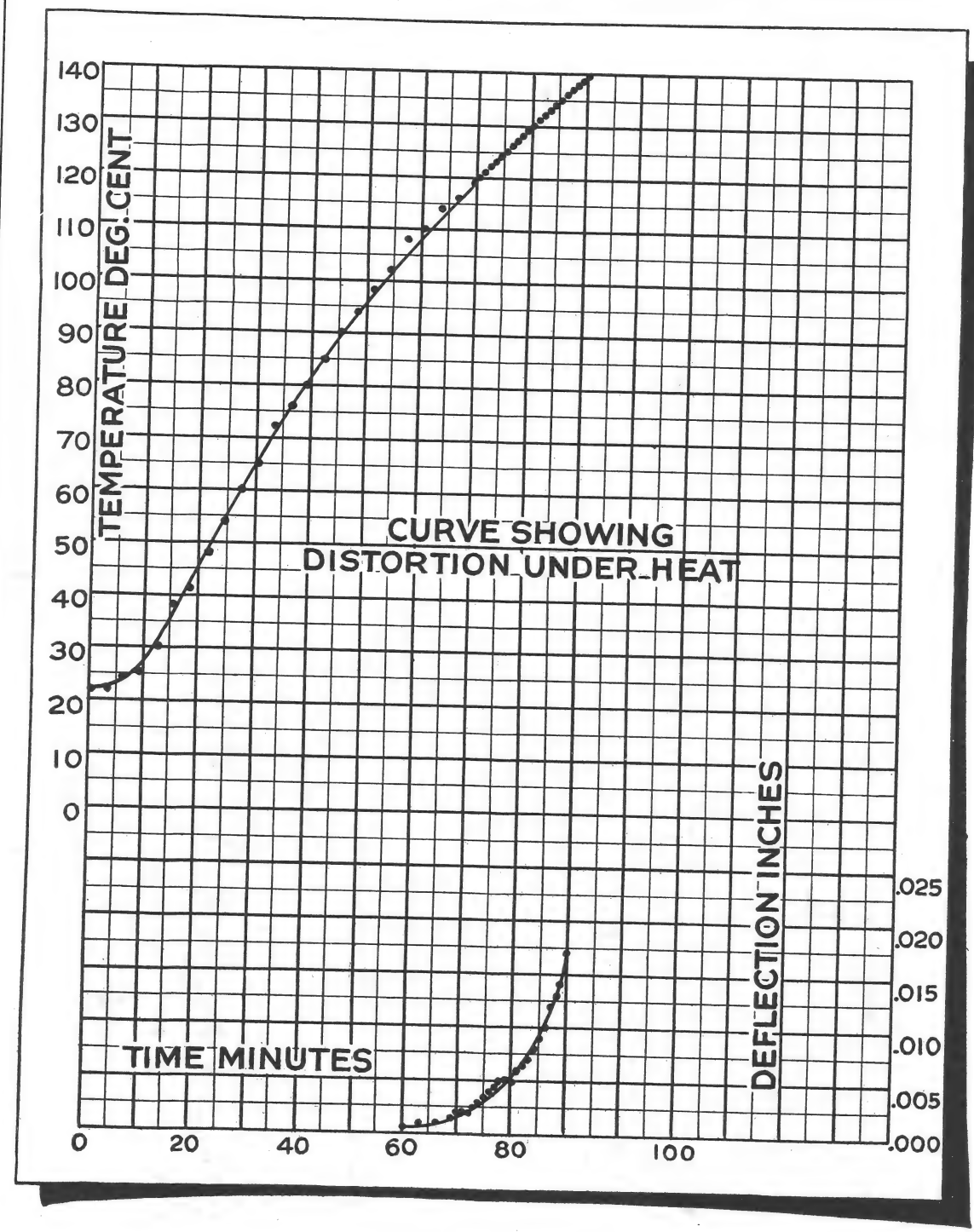
Marks on Original Package_____ Quantity_____

I hereby certify that all the material mentioned above has been examined, that samples tested show it to be a good delivery according to standard sample, and that it is therefore satisfactory for manufacturing purposes under our process specifications.

_____ Chemist.

INSPECTION FORM

LABORATORY HOOD



TYPICAL CURVE FROM TEMPERATURE TEST

Standard Methods of Testing Molded Insulation

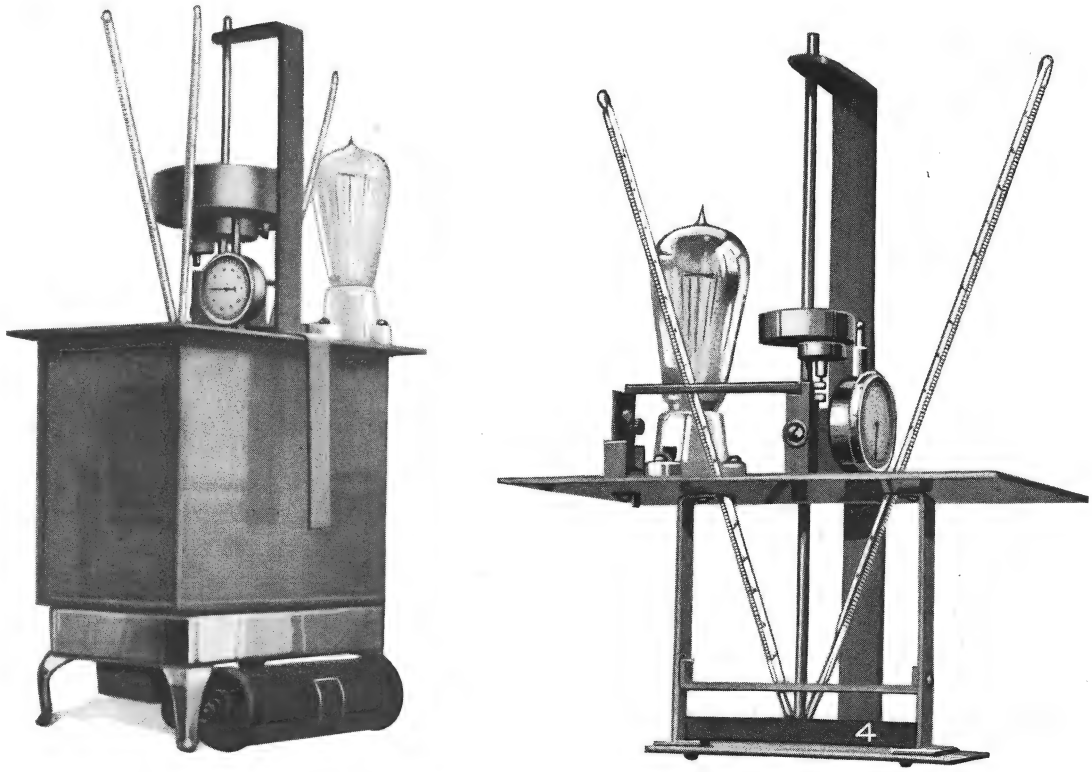
Temperature Tests

DISTORTION under heat of molded material, is best measured by special apparatus shown on this page. The standard test piece is supported on lugs about four inches apart with a varying load applied vertically in the center of the piece. The test is carried out in an air chamber completely surrounded by an oil bath, which can be heated electrically so that the temperature of the test piece can be raised gradually. The deflection is measured on a dial graduated in mils and the temperature can be read off either thermometer and recorded at intervals.

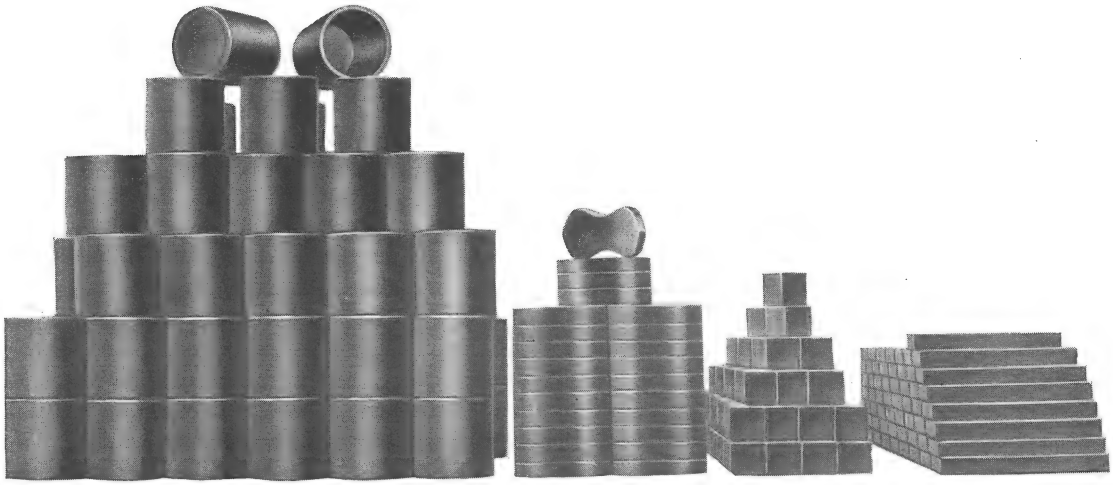
The distortion point is generally considered to be that degree of temperature at which the test piece has deflected ten one-thousandths of an inch at its center.

On the opposite page is a reproduction of an actual curve made on a piece of molded insulation, and it is always desirable to make this test whenever a new mixture or change in process specification becomes necessary.

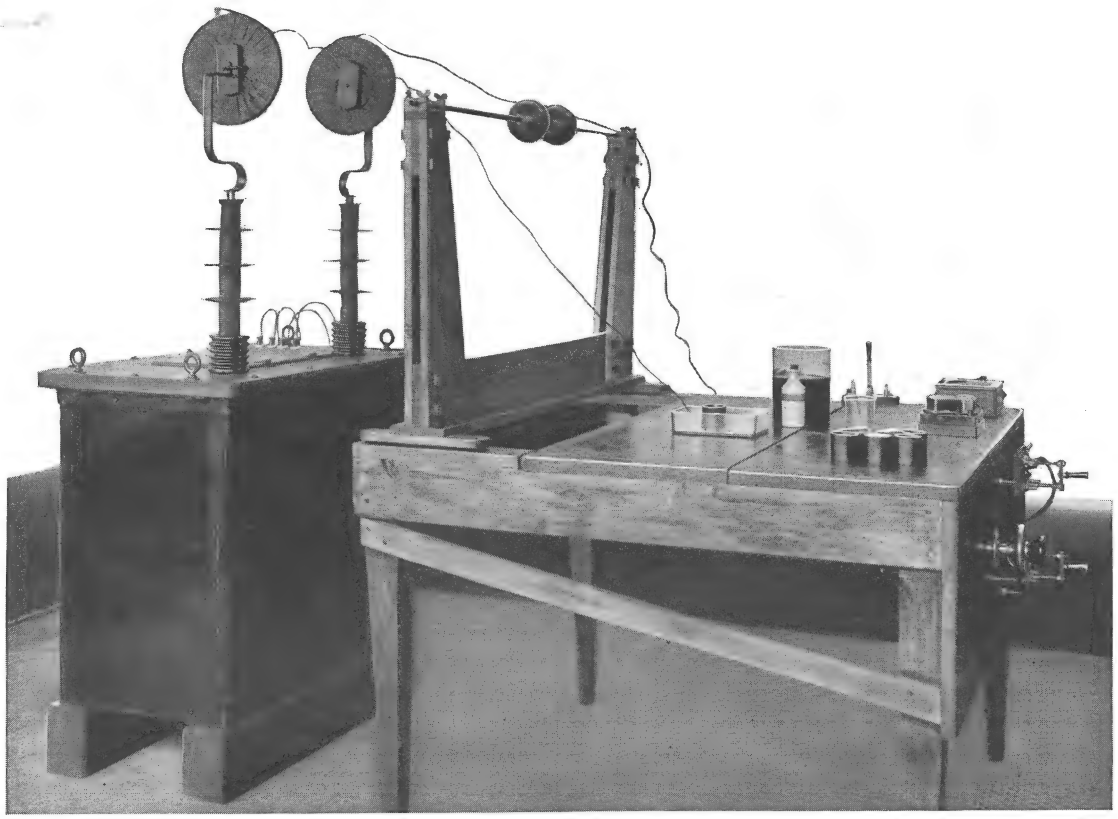
This method is much more satisfactory than the old way of holding the sample in an open flame and, except in cases where the inflammability—or combustibility—of a material is being considered, is of great value, and it shows exactly how the material behaves under an applied load at increasing temperatures.



TEMPERATURE TESTING APPARATUS



STANDARD TEST PIECES



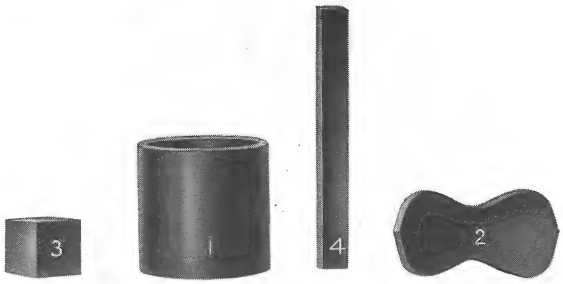
100,000-VOLT TESTING TRANSFORMER

Standard Methods of Testing Molded Insulation

Electrical and Mechanical Strength

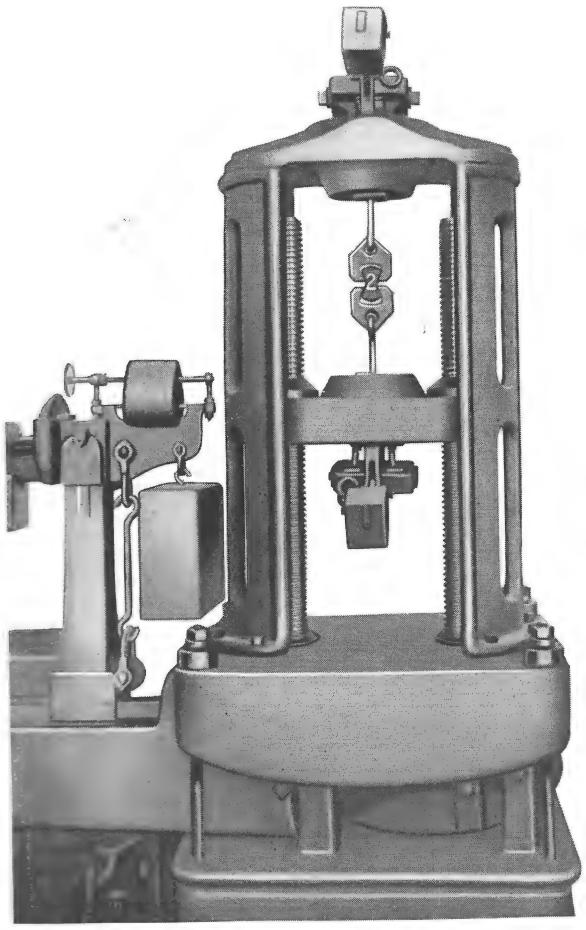
DISRUPTIVE STRENGTH

Material	Thickness Mils	Volts Per Mil
Bakelite	17	985
	25	680
Bakelite Asbestos	180	379
	315	250
Bakelite Wood-flour	150	545
	375	265
Hi-Tensit-72	39	846
	79	590
Hard Rubber	4	1500
	40	890



A. S. T. M. TENTATIVE STANDARDS

Tests on standard test piece No. 1 in transit oil at room temperature. Frequency sixty cycles—Bakelite Asbestos 379 volts per mil, and 214 volts per mil at temperature of 100° C. Bakelite Wood-flour 545 volts per mil at room temperature and 242 volts per mil at 100° C. Average of ten samples. Square root of mean square volts at puncture.



TESTING MACHINE

The disruptive strength of molded insulation does not increase in proportion to its thickness. Thin pieces show very much higher values in volts per mil than thick ones under exactly similar molding conditions.

For further details on methods of testing insulation see American Society for Testing Materials, transactions D-48-17T-Tentative Standard Tests on Molded Insulating Materials. Also the Standardization Rules of the American Institute of Electrical Engineers.

MECHANICAL STRENGTH

Molded Material	Pounds Tension per Sq. Inch	Compression Lbs. per Sq. Inch
Bakelite Asbestos	3,700	24,000
Bakelite Wood-flour	4,400	23,000
Hi-Tensit-72	1,500	2,800
Hard Rubber	1,200	2,200

Standard test pieces No. 2, No. 3, used for these tests at room temperature.

DON'TS FOR DESIGNERS OF MOLDED BAKELITE

1 Don't call for re-entrant curves or undercuts.

2 Don't call for thin walls or ribs or sharp inside corners where fillets can be used.

3 Don't call for long side holes with no provision for support.

4 Don't call for long inserts or wires supported only on the ends.

5 Don't specify small tapped holes in Bakelite Use inserts.

6 Don't design pieces with holes near edge or face

7 Don't have lugs or projecting inserts near edges or corners.

8 Don't call for thin layer of Bakelite over an insert.

9 Don't call for oblique holes.

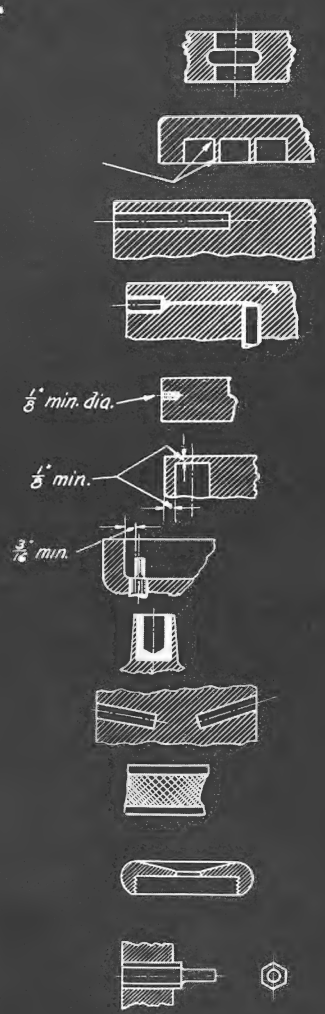
10 Don't specify cross knurling

11 Don't call for a large thread on the inside of a perfectly smooth round piece.

12 Don't show hexagonal or irregular shaped inserts projecting from Bakelite.

13 Don't specify depressed lettering or engraving This should be raised.

14 Don't specify tolerances of less than + or -.002" on small diameters or + or -.005" on large diameters unless absolutely necessary.



THERE ARE EXCEPTIONS TO ALL DONT'S

PRINT ISSUED

BOONTON RUBBER MFG. CO.
BOONTON, N. J.

DRAWN BY	CH'CK'D	APPR'V'D	DATE
TOOL ORDER NO.		NO.	TRACING NO.

Duplicate Parts

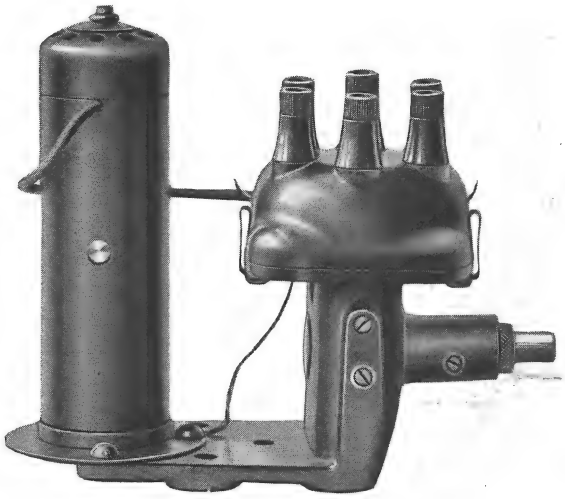
THE suggestions on the preceding page should be of interest to every buyer or user of duplicate parts which call for accurate dimensions, mechanical strength and resistance to heat or chemicals.

Bakelite is only half the weight of cast aluminum, and is especially adaptable to parts of considerable bulk. The pieces are alike and ready to be taken from the stock bin and used. No jigs or machine work; each piece is finished with inserts in place ready for use. No scrap or waste in machining to dispose of—and you buy only what you use.

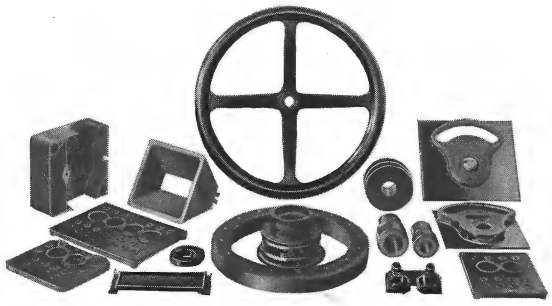
Many parts require large molds, and yet the quantity required is small. The parts therefore cost a good deal to manufacture when the cost of the mold is considered, but in many cases the cost is less than it would be if the same quantity was machined out of some other material, and the molded parts are very much better.

In the preceding pages we have endeavored to describe briefly the different kinds of molded insulation we manufacture and to give, in as few words as possible a description of the facilities we have for doing this work.

We are always ready and willing to furnish samples of our Bakelite compositions for you to test, and if necessary we will make up samples of the exact part you require, using the best mixture for the purpose.



BATTERY IGNITION



MISCELLANEOUS PARTS

MAGNETO IGNITION

Useful Data on Molded Insulation

THE data given here and on the following page will be of interest to the purchasing department as well as the engineering department of all manufacturers of electrical apparatus. More detailed information about compositions made up under any trade name can always be obtained from the manufacturer of the material. The figures given here are the averages from tests on a number of samples and are sufficiently accurate to be used for comparison. It must be remembered that the characteristics of any composition vary according to the way in which it is made. Mixtures vary, and duplicate tests on the same composition will often show wide variation due to lack of uniformity of temperature and pressure.

COEFFICIENTS OF EXPANSION AT 37° C.
(Per Inch per Degree Centigrade)

Brass	.0000187
Bronze	.0000180
Copper	.0000173
Hard Rubber	.0000770
Bakelite	.0001000
Bakelite Wood-flour	.0000478
Bakelite Asbestos	.0000300
Hi-Tensit-72	.0000360

There are a number of electrical properties of insulating materials which seem to relate to each other, notably the resistance through the material itself, the resistance over the surface, the disruptive strength and the specific inductive capacity, but just what this relationship is has yet to be discovered.

The relative importance of the figures given in the accompanying tables to the user of molded material, will depend largely on the way in which the material is used. No figures have been given on the specific resistance of materials, either as to volume or surface resistivity, because it is very difficult to measure such resistance above 100,000 megohms, and because the results vary widely on the same composition according to the way in which the tests are carried out.

A very excellent scientific paper has been published on this subject by the Bureau of Standards at Washington, entitled "Insulating Properties of Solid Dielectrics," Bulletin No. 234, June 8, 1914, by Dr. Harvey L. Curtis.

It is also interesting to know that the Insulation Committee of the Engineering Division, National Research Council has undertaken the tabulation of existing data on insulating materials.

TRANSVERSE BREAKING STRENGTH

Molded Material	Load in Pounds Center of 3" Span	Deflection Inches
Bakelite Asbestos	160	.032
Bakelite Wood-flour	170	.063
Hi-Tensit-72	155	.094
Hard Rubber	150	.125

Test made at room temperature on molded pieces ¼ x ¾ x 4 laid flat.

SPECIFIC GRAVITY, 16° C.

Aluminum, cast	2.67
Bakelite, pure	1.25
Bakelite, Wood-flour	1.36
Bakelite, Asbestos	1.89
Hi-Tensit-72	1.74
Hard Rubber	1.18
Shellac	1.15
Red Fibre	1.35

SPECIFIC INDUCTIVE CAPACITY

Bakelite, pure	8.85
Bakelite Asbestos Composition	2.10
Bakelite Wood-flour	4.20
Hi-Tensit-72	2.60
Hard Rubber	3.48

Classification of Molded Material

Class 1. SYNTHETIC

Condensation products of phenol and formaldehyde used as the binding material. Fillers, either organic like wood-flour, or inorganic like asbestos. Structure can be laminated using condensation product to bind sheets together under heat and pressure. Pieces molded hot, either plastic, or positive in hard steel molds with high degree of accuracy. Product will not soften under heat, but will carbonize. Chemically inert. Colors: red, black and brown with high polish, if desired. Strongest insulation known mechanically. Metal inserts can be molded in place.

Class 2. RESINOUS

Includes hot and cold molded products, with various binders like shellac, copal or Damar gums. Fillers usually mica or inorganic materials like asbestos. Very plastic and can be molded to any shape. Good insulation, but will not withstand temperatures much above boiling point of water, even when made with silicates. Inserts can be molded in place. Chemically very stable, but hydration products set up after long exposure. Low mechanical strength. Colors: black, green, brown or red, with good polish when required.

The cold molded products cannot be molded so exactly to size, but stand greater heat. Both the hot and cold molded products are used extensively wherever cheap insulators are required. Like hard rubber compositions, the greater the percentage of mineral filler, the lower the dielectric strength. Parts can be made which look exactly like hard rubber, but are very much more brittle.

Class 3. CELLULOSE

Fibrous products with organic or inorganic binding material, laminated or not. Best example is common indurated fibre, which is vegetable fibre treated with metallic chlorides. Cannot be molded, but is pressed into sheets rods and tubes, and afterwards cut to size. Will not stand moisture, but has high mechanical strength and can be machined easily. Colors: red, grey and black. One of the most widely used materials when small quantity of pieces or cheap insulation is desired.

Class 4. INORGANIC

All vitrified products, like glass and porcelain, and also inorganic materials held together with silicates, hydraulic cement or magnesium oxychloride—cold molded and used in all cases where ability to withstand high temperatures is desired. Usually light brown or white color; good insulator. Cannot be molded to exact size and cannot be machined except in case of wet process porcelain before firing. Mechanically strong, but fragile. Metal inserts cannot be molded in place except cold molded products. Smooth surface, usually glazed.

Class 5. RUBBER

Vulcanized rubber products are those hardened by use of sulphur and heat. Hard rubber contains over 30 per cent. sulphur and is cured a relatively long time compared to soft rubber, which contains less than 2 per cent. of sulphur. Hard rubber can be made to contain less than 1 per cent. or more than 50 per cent. mineral fillers as determined by ash tests. The electrical value depends entirely on quality and can be made very high. It can be machined easily and takes a very high polish, but will not stand temperatures much above 100° C. Color, black. Flexible and not brittle. Easily molded. Brass inserts must be tinned to resist the action of free sulphur.

Class 6. BITUMINOUS

Products with mineral binders like asphalt, can be hot or cold molded. Withstands fairly high temperatures and is used for insulation in domestic heating appliances where accuracy is not required. Not very strong mechanically or electrically, but not brittle like porcelain. Color, usually black. Can be machined with difficulty. Withstands weather properly and is widely used wherever a cheap insulation is needed. Inserts can be molded in place.

This material is generally used for lamp sockets, switch handles, bases and parts which are often made of porcelain. It can be polished and makes a good appearance for either in or out door work. Asphalts and mineral pitches are unaffected by water, acids or alkalies and have high electrical values and low costs.

OUR PRODUCTS ARE COVERED BY CLASS 1 AND CLASS 5

ESTABLISHED AT BOONTON IN 1891

Produced by the
BOONTON RUBBER MANUFACTURING COMPANY
and
HIGGINS & LOW, INC., New York
Photographic Illustrations by HORACE W. SCANDLIN
New York
Printed by
REDFIELD-KENDRICK-ODELL CO., INC.
New York